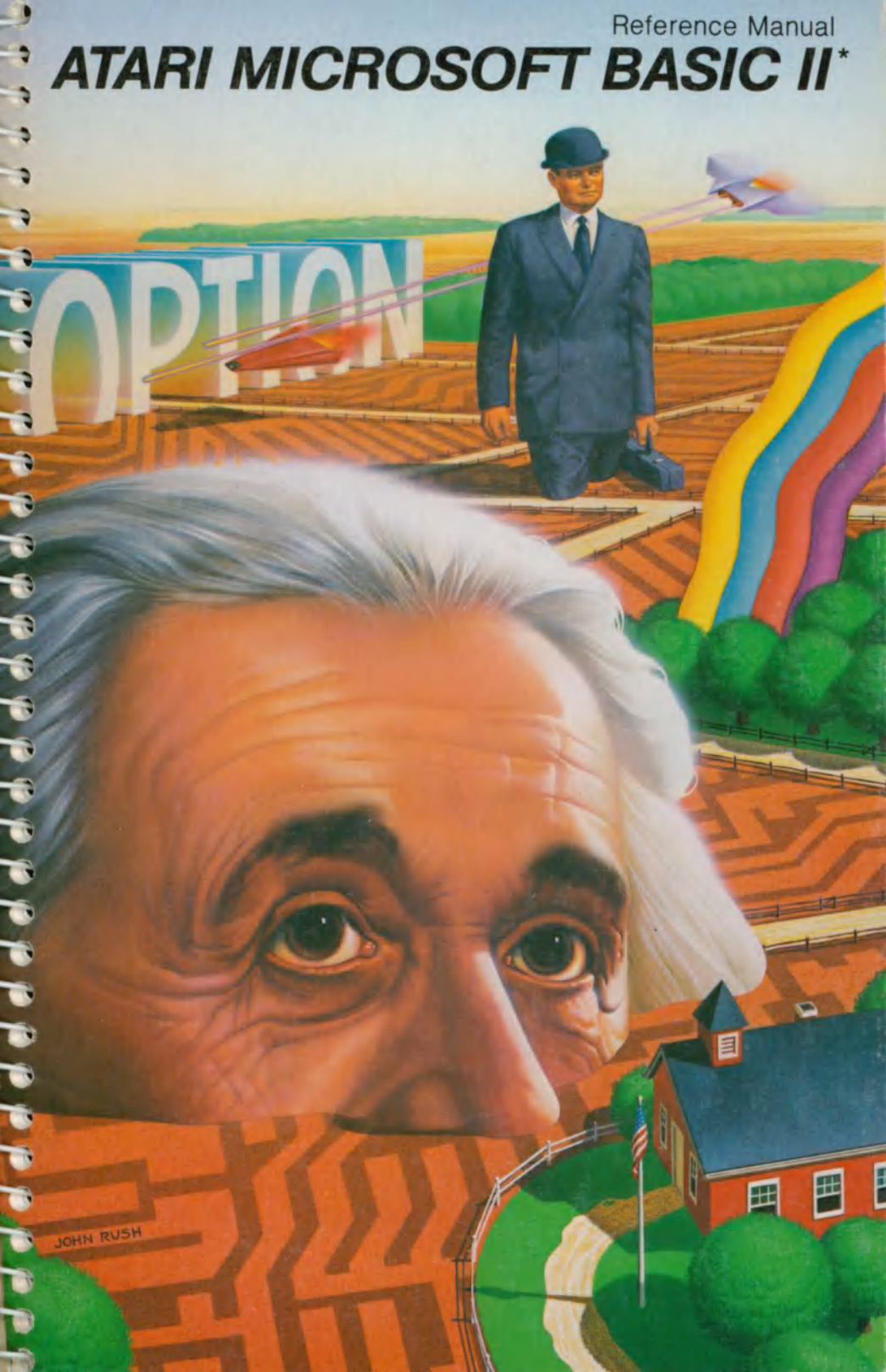
Reference Manual

ATARI MICROSOFT BASIC II*



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PREFACE

In this manual you will find all the commands and statements used by **ATARI® Microsoft BASIC II**. The KEYWORDS list on the inside front cover is in alphabetical order with page numbers for your convenience.

BASIC was developed at Dartmouth College by John Kemeny and Thomas Kurtz. It was designed to be an easy computer language to learn and use. Many additions in recent years have made BASIC a complete and useful language for skilled programmers.

This manual is intended as reference material for use with ATARI Home Computer Systems. It is written for those with a working knowledge of BASIC programming. It is not a tutorial, nor is it intended as an introduction to ATARI Microsoft BASIC II.

Important: Programs developed under the diskette-based version of ATARI Microsoft BASIC can be run using ATARI Microsoft BASIC II.

A WHOLE NEW WORLD OF CREATIVE PROGRAMMING 1

Welcome to the world of ATARI Microsoft BASIC II, the most advanced BASIC programming language available on a 16K Read-Only Memory (ROM) cartridge for use with ATARI Home Computers. Insert the cartridge into your ATARI Home Computer and discover the amazing versatility and speed of Microsoft BASIC II!

One of the first things you notice about MIcrosoft BASIC II is its relaxed handling of strings. Now you can use one-dimensional strings without telling the computer in advance. Microsoft BASIC II also goes one step further, allowing multidimensional arrays of variables and strings. You can enter your program line numbers automatically with AUTO and delete one or any number of lines with DELETE. Hyphens (-) stake out the range of line numbers when you're using LIST or DELETE. If you're not satisfied with the jumble of line numbers in your program after a long session, you can renumber them with RENUM. And Microsoft BASIC II uses several commands dealing with DOS files: KILL, LOCK, UNLOCK, and NAME—these are only a few of the new commands that work from inside your Microsoft BASIC II program.

No syntax checking is done as you enter a program line from the keyboard. Microsoft BASIC II checks for errors when you RUN your program, allowing you to trace errors right to their source with TRON and TROFF. While it's probably impossible to be pleasantly surprised by an error, at least now you have the benefit of seeing your error described in plain English! Other bonuses for you include Microsoft BASIC II's floating-point accuracy (to 16 digits) and its ability to preset variable types: integer, single-precision real, or double-precision real (DEFINT, DEFSNG, or DEFDBL), and hexadecimal. The default for constants and variables is single-precision real, and you can change a variable's precision simply by appending "%" for integers or "#" for double-precision real. Also, Microsoft BASIC II implements math functions more rapidly by utilizing the interpreter rather than the operating system ROM routines.

If you've ever wondered about the difference between tokenized and untokenized programs, you can relax. Microsoft BASIC II includes a MERGE command that works with either one. Simply MERGE your program into an existing program in memory.

It's this kind of versatility that has earned Microsoft its excellent reputation among professional programmers. Microsoft BASIC II places the most advanced strategies of BASIC programming at your fingertips. You can shift entire sections of memory from place to place with the command MOVE. Graphics programmers add FILL to their palette of programming shortcuts. There's even an added dimension for SOUND; now you can include the length of time a sound is to be played. Interested in longer pauses for your programs? The AFTER command lets you change your program's course—even as long as 24 hours later! There are several different OPTION commands. With OPTION BASE, you can set your own default level for arrays to 1, even though the start-up default is the usual 0. The OPTION PLM command reserves space in RAM for your player-missile graphics, while OPTION RESERVE lets you automatically protect memory for those special machine language routines, and OPTION CHR can be used to set aside memory for switching character sets.

The list goes on and on. Define your own special functions with DEF, and do more versatile plotting, pointing, and printing with such commands as PLOT. . .TO, SCRN$, and PRINT AT. PRINT USING gives you 12 different screen or printer formats for handling figures, decimal points, and numerous other report or form requirements. ATARI Microsoft BASIC II opens the door to a whole new world of creative programming!

WHAT SIZE SYSTEM?

To use the ATARI Microsoft BASIC II cartridge you must have a minimum system that consists of an ATARI Home Computer with 16K of RAM (Random Access Memory) and a standard TV set or monitor. If you want to load and save Microsoft BASIC II programs on cassette or diskette, you also need an ATARI 410™ Program Recorder or an ATARI 810™ Disk Drive. The Microsoft BASIC II Extension Diskette requires an ATARI 810 Disk Drive and can only be used with ATARI Disk Operating System version 2.0S.

LOADING MICROSOFT BASIC II

If you do not have a disk drive, follow these steps to load your ATARI Microsoft BASIC II cartridge:

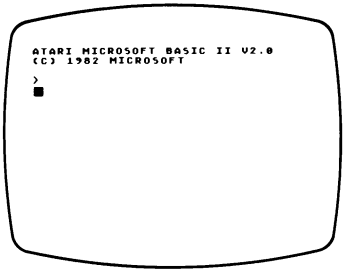
1. Turn on your ATARI Home Computer by pressing the power switch on the right side of the console to ON.
2. Pull the release lever toward you to open the cartridge door. (Whenever you do this, the computer automatically turns itself off.)
3. Insert the ATARI Microsoft BASIC II cartridge in the cartridge slot (the left cartridge slot in your ATARI 800™ Home Computer) with the label facing you. Press the cartridge down carefully and firmly. Close the cartridge door and the computer turns on again.
4. Microsoft BASIC II then takes command and loads itself into your computer's memory.

If you have a disk drive, follow these steps to load Microsoft BASIC II with the Extension Diskette:

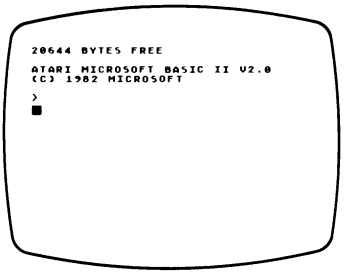
1. Make sure the power switch on the right side of your ATARI Home Computer console is turned off.
2. Pull the release lever toward you to open the cartridge door.
3. Insert the Microsoft BASIC II cartridge in the cartridge slot (the left cartridge slot in your ATARI 800 Home Computer) with the label facing you. Press down carefully and firmly. Close the cartridge door.
4. Turn on disk drive 1. Wait until the red BUSY light goes off.
5. Insert the Microsoft BASIC II Extension Diskette in the disk drive. Make sure the label faces up and to the right.
6. Close the door of the disk drive.
7. Turn the power switch on the right side of the console to ON.
8. Microsoft BASIC II then takes command and loads itself into your computer's memory automatically.

CHECKING THINGS OUT

You'll know Microsoft BASIC II has loaded properly when you see the following information on your TV screen:



WITHOUT DISK DRIVES



WITH DISK DRIVES

(If you do not see one of the above screens, turn off your computer and start over at the "LOADING MICROSOFT BASIC II" section.)

COPYING THE MICROSOFT BASIC II EXTENSION DISKETTE

Your Microsoft BASIC II Extension Diskette contains several files that add convenient commands and features to the cartridge program of Microsoft BASIC II. These files are: DOS.SYS, DUP.SYS, AUTORUN.SYS, RS232.SYS, CIOUSR, and MEM.SAV. To prevent the overlaying and destroying of these important files, the extension diskette comes in a "write-protected" jacket (one without a notch), which means that you cannot save programs on the original diskette. For this reason, you need to make a copy of the extension diskette before you begin to write your own programs.

Follow these steps to prepare your working copies of the Microsoft BASIC II Extension Diskette:

1. With the extension diskette in your disk drive, Microsoft BASIC II loaded, and the ready prompt (>) showing, type **DOS** and press [RETURN]. Your TV screen displays the DOS menu when DOS is finished loading, which takes about 30 seconds.
2. Remove the extension diskette from the disk drive.
3. Insert a diskette to be formatted in your disk drive.
4. Here's what the computer asks and how you respond:

COMPUTER: SELECT ITEM OR **RETURN** FOR MENU
YOU TYPE: I **RETURN**

COMPUTER: WHICH DRIVE TO FORMAT?
YOU TYPE: 1 **RETURN**

COMPUTER: TYPE "Y" TO FORMAT DISK 1
YOU TYPE: Y **RETURN**

5. The disk drive whirs and clicks for less than a minute. You'll know the formatting process is finished when the screen displays "SELECT ITEM OR RETURN FOR MENU" again.

After your diskette has been formatted, you're ready to duplicate the extension diskette. Press **RETURN** for the DOS menu. Next insert the extension diskette into your disk drive. Follow these steps to make a working copy:

YOU TYPE: J **RETURN**
COMPUTER: DUP DISK-SOURCE,DEST DRIVES?

YOU TYPE: 1,1 **RETURN**
COMPUTER: INSERT SOURCE DISK, TYPE RETURN

YOU TYPE: **RETURN**
COMPUTER: TYPE "Y" IF OK TO USE PROGRAM AREA
CAUTION: A "Y" INVALIDATES MEM.SAV

(MEM.SAV is a file that saves your BASIC II program whenever you go to the DOS menu. Invalidating it frees memory for duplication of diskettes.)

YOU TYPE: Y **RETURN**
COMPUTER: INSERT DESTINATION DISK, TYPE RETURN

(At this point, remove the extension diskette and insert your formatted diskette.)

YOU TYPE: **RETURN**
COMPUTER: INSERT SOURCE DISK, TYPE RETURN

(Remove the formatted diskette and insert the extension diskette.)

YOU TYPE: **RETURN**
COMPUTER: INSERT DESTINATION DISK, TYPE RETURN

(Remove the extension diskette and insert the formatted diskette again.)

YOU TYPE: **RETURN**
COMPUTER: SELECT ITEM OR *RETURN* FOR MENU

The process of duplicating the extension diskette requires you to switch the diskettes in the disk drive twice. When the computer displays "SELECT ITEM OR RETURN FOR MENU," copying is completed. You can check both directories to see if all is well: Type **A** and press **RETURN** and then press **RETURN** again. A list of files appears on your TV screen. Then do the same thing with the other diskette in the disk drive. (For further information, see *An Introduction to the Disk Operating System* or the *ATARI Disk Operating System II Reference Manual.*)

6. When you invalidate the MEM.SAV file, you lose the disk extension features. In order to restore the use of these features, you must reload Microsoft BASIC II. Turn the power switch on the right side of your computer console to OFF and then turn it to ON again.

7. Whenever "SELECT ITEM OR *RETURN* FOR MENU" appears on your TV screen, you may leave the DOS menu and return to Microsoft BASIC II by typing **B** (the "RUN CARTRIDGE" selection on the DOS menu). After Microsoft BASIC II is re-entered, the prompt (>) will appear. Microsoft BASIC II is now ready to receive your commands.

Note: When returning to the cartridge, it is important that the diskette from which you loaded DOS is in the disk drive. The system may lock up if another diskette is used.

STARTING POINTS

This reference manual describes all the programming advantages of ATARI Microsoft BASIC II. It contains the information you'll need to start developing simple or complex computer programs in Microsoft BASIC II.

DIRECT AND DEFERRED MODES

Microsoft BASIC II accepts commands in both the deferred and direct modes—that is, you can type commands and execute them directly, or you can begin with line numbers to create programs that execute after you command the computer to RUN. Microsoft BASIC II accepts line numbers from 0 to 63999.

The "ready" (>) prompt on your TV screen means that the computer is ready to take commands. As you type a command, it begins appearing where the cursor block is located—just beneath the prompt sign. You can type a direct command and press the **RETURN** key for immediate results:

```
>
YOU TYPE:  PRINT "HI, I'M YOUR NEW BASIC II." RETURN
COMPUTER: HI, I'M YOUR NEW BASIC II.
```

Or you can type a line number and begin programming in the deferred mode:

```
YOU TYPE:  10 PRINT "YOU'LL LIKE ME." RETURN
```

In the deferred mode, nothing happens when you press **RETURN**; the computer stores the information in its memory. The actual execution is deferred until you type the command RUN and press **RETURN**:

```
YOU TYPE:  RUN RETURN
COMPUTER: YOU'LL LIKE ME.
```

Since the command RUN is typed without a line number, it's executed directly, beginning the program at the first line number.

RESERVED WORDS (KEYWORDS)

A computer carries out any command that it understands. The Microsoft BASIC II programming language uses English-like words as commands. These words are called *keywords* or *reserved words.* A keyword like "PRINT" orders the computer to write on the TV screen. The computer recognizes these keywords as special words; it knows how to deal with them. There are more than 100 reserved words in the vocabulary of Microsoft BASIC II. If you spell a keyword wrong or use one that the computer doesn't recognize, Microsoft BASIC II prints an error message. Keywords cannot be used alone as variable names in a program, but they can be used as part of a variable name. For example, IF and GOSUB are keywords and cannot be used as variables, but LIFE and RGOSUB are allowed. You can find a complete list of keywords on the inside cover of this book and in Appendix N.

THE MICROSOFT BASIC II PROGRAM LINE

Every Microsoft BASIC II program line consists of a line number followed by a BASIC statement. The line numbers help Microsoft BASIC II keep track of the sequence of commands, executing them in the proper order.

```
Line #   Statement
100      IF A=B THEN PRINT "EQUAL" ELSE PRINT "NOT EQUAL"
```

THE RULES OF PUNCTUATION

Just as there are punctuation marks in English, so there are punctuation marks in Microsoft BASIC II. The rules of punctuation depend on the particular requirements of Microsoft BASIC II commands. One general rule requires that all commands must be in UPPERCASE. Other rules pertain to the spaces between commands and their parameters, and to the use of quotation marks, commas, colons, semicolons, and other punctuation marks.

Spaces

Microsoft BASIC II has one rule regarding the use of spaces in your programs: Each keyword must have a space before and after it. However, there are times when a space is not mandatory—for example, when a delimiter (such as a quotation mark) follows the command and is an integral part of it, the space is optional. As a general rule, however, write your programs as you write normal sentences—with a space before and after each keyword.

Quotation Marks

Quotation marks are used to indicate where typed characters begin and end. Just as we use quotation marks in written English to mark the beginning and end of a speaker's words, so it is with BASIC statements. Quotation marks tell the computer where to begin and end printing. Double quotation marks allow the use of quotation marks in the printed result.

Example Program:

YOU TYPE: 100 PRINT "START PRINTING ON SCREEN-----NOW STOP"

YOU TYPE: 110 PRINT " ""START AGAIN . . . STOP"""

YOU TYPE: RUN **RETURN**

COMPUTER: START PRINTING ON SCREEN-----NOW STOP
"START AGAIN . . . STOP"

Note: You are now on your own. We won't bother to direct you with "YOU TYPE" and "COMPUTER."

Commas

The comma has three uses.

- Use the comma to separate required items after a keyword. The keyword SOUND has five different functions in ATARI Microsoft BASIC II. Each parameter is separated by commas. For example, SOUND 2,&79,10,8,60 means voice 2, pitch hexadecimal 79 (middle C), noise 10, volume 8, and duration in jiffies (1/60 of a second) 60 or one second. Another example of the comma is the statement SETCOLOR 4,4,10, which means register 4, pink, bright luminance. The comma tells where one piece of information ends and the next begins. BASIC expects to find the parameters for a command in an exact order separated by commas.
- Use the comma to separate optional values and variable names. You can enter any number of variable names on a single line with an INPUT statement. Use as many of them as you like as long as you separate them with commas. For example, INPUT A,B,C,D,E tells the computer to expect five values from the keyboard.
- Use the comma to advance to the next column in a PRINT statement. When used at the end of a quotation or between expressions, the comma will advance printing to the next column that is a multiple of 14 spaces. For example, if X is assigned the value of 25, then the statement 10 PRINT "YOU ARE", X, "YEARS OLD" has the following spacing when you run it (your TV screen is wide enough for only 2 columns; hence, the second line):

```
|               |               |
|< 14 spaces >|< 14 spaces >|
|               |               |
YOU ARE         25
YEARS OLD
```

Semicolons

The semicolon is used for PRINT statement output. The semicolon leaves one space after variables and constants, a leading blank space before positive numbers, and a minus sign but no preceding blank space before negative numbers. For example, if X is assigned the value of 25, then the statement 10 PRINT "YOU ARE";X;"YEARS OLD" has the following spacing when the program is run:

YOU ARE 25 YEARS OLD

If X is assigned the value of -25, then the statement 10 PRINT "YOU ARE";X;"YEARS OLD" has the following spacing when the program is run:
YOU ARE-25 YEARS OLD

If you want more than one space left before and after the 25, you must leave the space in the string within the quotation marks. Thus,——

10 PRINT "YOU ARE ";25;" YEARS OLD"

——gives the following spacing when the program is run:
YOU ARE 25 YEARS OLD

The semicolon can also be used to bring two PRINT statements, string constants, or variables together on the same line of the television screen. For example:

```
100 PRINT "THE AMOUNT IS $";
120 AMOUNT = 20
130 PRINT AMOUNT
```

YOU TYPE: RUN **RETURN**
COMPUTER: THE AMOUNT IS $ 20

Colons

The colon is used to join more than one statement on a line with a single line number. Thus, many statements can execute under the same line number. By joining more than one statement on a single line, the program requires less memory. You can use up to three screen lines or slightly less than 120 characters for each numbered line.
For example: 10 X = 5:Y = 3:Z = X + Y:PRINT Z:END

Many times this also helps the programmer organize the program steps. The same program with line numbers instead of colons uses more bytes of memory:

```
10 X = 5
20 Y = 3
30 Z = X + Y
40 PRINT Z
50 END
```

Editing

The ATARI 400™ and 800 Computer keyboards have features that differ from those of an ordinary typewriter; to begin with, the standard characters are uppercase letters. To print lowercase letters, press the **CAPS LOWR** key. The keyboard now operates like a typewriter, with the **SHIFT** key giving uppercase letters. Since most BASIC programs are written in uppercase, you will normally want to return to the uppercase mode. Press the **SHIFT** key and hold it down while you press the **CAPS LOWR** key to return to uppercase letters.

Control and Shift Keys

The cursor control keys allow immediate editing capabilities. These keys are used in conjunction with the **SHIFT** or **CTRL** keys. The keys that offer special editing features are described in the following paragraphs.

Hold the **CTRL** control key down while pressing the arrow keys to move the cursor anywhere on the screen without changing any characters already on the screen. On those keys that have three functions, striking a key while pressing the **CTRL** key produces the upper left symbol.

CTRL ↑	Moves cursor up one line without changing the program or display.
CTRL →	Moves cursor one space to the right without disturbing the program or display.
CTRL ↓	Moves cursor down one line without changing the program or display.
CTRL ←	Moves cursor one space to the left without disturbing the program or display.

For the previous four functions, if the cursor is on the edge of the screen, moving it off the edge causes it to reappear on the opposite side of the screen (wraparound).

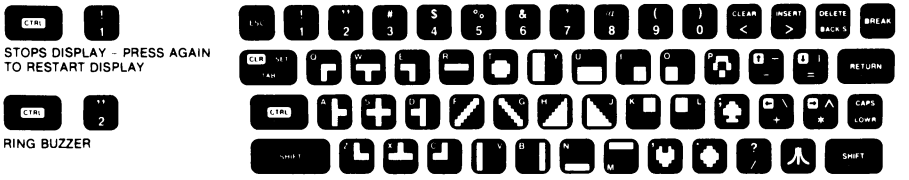
CTRL INSERT	Inserts one character space.
CTRL DELETE BACK S	Deletes one character or space.
CTRL 1	Temporarily stops or restarts screen display. You can use **CTRL 1** while listing a program or while running a program.
CTRL 2	Rings the buzzer in the computer console.

Hold the **SHIFT** key down while pressing the numeric keys to display the symbols shown on the upper half of those keys.

SHIFT INSERT	Inserts one line.
SHIFT DELETE BACK S	Deletes one line.
SHIFT CAPS LOWR	Returns screen display to uppercase alphabetic characters.

Control Graphics

The control key **CTRL** functions as a second type of shift. When it is depressed in conjunction with another key, a character from a completely new set of characters appears on the screen. These "graphic" characters can be used to produce interesting pictures, designs, and graphs either without a cartridge or with the ATARI BASIC cartridge. The diagram on the next page shows the graphic characters produced by each CTRL plus key combination.



SPECIAL FUNCTION KEYS

Inverse Video Key or ATARI logo key. Press this key to reverse the brightness of the character with its background on the screen. Press the key a second time to return to normal text (light text on dark background).

CAPS LOWR — **Lowercase Key.** Press this key to shift the screen characters from uppercase (capitals) to lowercase. To restore the characters to uppercase , press the **SHIFT** key and the **CAPS LOWR** key simultaneously.

ESC — **Escape Key.** Press this key to enter a screen editing command for later execution (deferred mode). In the direct mode, clear the screen by pressing **CTRL** and **CLEAR** simultaneously. In the deferred mode, for example, enter the following:

10 PRINT "**ESC CTRL CLEAR**"

and press **RETURN**. Then, whenever line 10 is executed, the screen is cleared. (Microsoft BASIC II also allows you to type **CLS** in direct or deferred modes to clear the screen.)

ESC is used in conjunction with other keys to print special graphics control characters.

BREAK — **Break Key.** This key stops your program execution or program list, prints a > on the screen, and displays the cursor underneath. You may resume execution by typing **CONT** and pressing **RETURN**.

SYSTEM RESET — **System Reset Key.** This key stops program execution, returns the screen display to graphics mode 0, clears the screen, and resets all the default values.

CLR SET TAB

Tab Key. Press **SHIFT** and the **CLR SET TAB** keys simultaneously to set a tab. To clear a tab, press the **CTRL** and **CLR SET TAB** keys simultaneously. Used alone, **CLR SET TAB** advances the cursor to the next tab position. In deferred mode, set and clear tabs by adding a line number, the command PRINT, and a quotation mark, and pressing the **ESC** key.
Examples:
100 PRINT "**ESC SHIFT CLR SET TAB**
200 PRINT "**ESC CTRL CLR SET TAB**

If tabs are not set, they default to columns 7, 15, 23, 31, and 39.

RETURN

Return Key. This key is used to terminate a BASIC command or a statement. Press this key after each command in direct mode or after entering a program line.

PROGRAM ELEMENTS 2

CONSTANTS AND VARIABLES

Constants are numbers or letters that you use in a program. They remain the same throughout the program. These are examples of constants: 5, "JACK".

Variables are names assigned to numbers or letters. The contents of a variable may change during a program. These are examples of variables: A, J$.

There are five types of constants and variables in ATARI Microsoft BASIC II: integer, single-precision real, double-precision real, hexadecimal, and string.

FORMING A VARIABLE NAME

The allowable characters in a variable name include the alphabet letters A to Z, numbers 0 to 9, and an underscore (_). The underscore character (_) is a legal character in ATARI Microsoft BASIC II. Numbers are allowed as long as the variable name starts with an alphabetic character. The variable name X9 is allowed, while 9X is not allowed.

SPECIFYING PRECISION OF NUMERIC VARIABLES

You can specify the variable type in two ways:

- Predefine the starting letter of a variable using DEFINT, DEFSNG, DEFDBL, or DEFSTR.
- Tag the variable with a type identifier (%, #, $).

The advantage of predefining the variable type is that you can change all the variables from one type to another without having to go through your program changing all variable names. Changing DEFINT A to DEFDBL A, for example, changes all variables beginning with the letter A from integer type to double-precision type. Your other option is to use a type tag identifier: # (double precision), %(integer), and $ (string). Tag identifiers are attached to the end of the variable name itself. If variables should have both DEF identification of type and a tag identifier (#, %, $), the tag identifier has precedence.

Although DEFSNG, DEFDBL, DEFINT, and DEFSTR can be placed anywhere in a program, they are usually placed near the beginning.

INTEGER CONSTANTS

Examples: 23, -9999, 709, 32000

All whole numbers in ATARI Microsoft BASIC II within the range -32768 to +32767 are stored as two bytes of binary. If an integer constant is multiplied with a single-precision real number, the product of the multiplication is a single-precision real number. The results of mathematical operations are always stored in the higher-level precision type.

Negative integers are stored as twos complement binary.

INTEGER VARIABLES

Examples: SMALLNO%, J%, COUNT%

An integer can be identified by having a percent sign (%) as the last character in the variable name. An example of an integer identified by name is NO%. (The 16-bit integer is stored as twos complement binary.)

DEFINT

Format: DEFINT letter,|beginning_letter-ending_letter|
Examples: 10 DEFINT N, J, K-M
20 DEFINT I

Note: The vertical lines in the format indicate an optional portion of the statement. You will see these options identified in formats throughout the reference manual.

The starting letters of variable names identified by the DEFINT statement are integers. Integer variables increase the speed of processing but can only accurately hold values between -32768 and + 32767. Remember that tag identifiers have precedence. Even though N is defined by DEFINT as being an integer type, the pound sign appearing after the N identifies it as double precision. N#, N1#, NUMB# are all double-precision numbers because the pound sign (#) means double precision.

Figure 2-1 illustrates how integers are represented in memory.

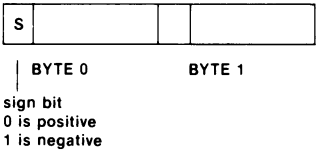


Figure 2-1 Machine Representation of Integer Variable

SINGLE-PRECISION REAL CONSTANTS

Examples: 65E12, 333335, .45E8, .33E-6

All constants typed into a program outside the range -32768 to 32767 are single-precision real numbers.

SINGLE-PRECISION REAL VARIABLES

Examples: AMT, LENGTH, BUFFER

If you do not declare the precision of a variable, it becomes single-precision real by default. Numbers stored as single precision have an accuracy of six significant figures. The exponential range is -38 to + 38.

DEFSNG

Format: DEFSNG letter,|beginning_letter-ending_letter|
Examples: 100 DEFSNG K, S, A-F
120 DEFSNG Y

Variable names beginning with the first letters identified in DEFSNG are single-precision real variables. In DEFSNG K, S, A-F, the letter range A-F means A, B, C, D, E, F are all single precision. Variable names starting with K and S are also single precision in this example. Single letters and ranges of letters must be separated by commas.

Example Program:

```
10 DEFSNG A-F
20 COUNTER = COUNTER + 1
30 PRINT COUNTER
40 GOTO 20
```

In the DEFSNG example program, all variable names beginning with the letter C are single precision. Thus, COUNTER is single precision in this example because it starts with C. If counter were named COUNTER # (# means double precision), it would have double precision even though it is defined as single precision. Keep in mind that the tag identifier in a variable name takes precedence.

Figure 2-2 illustrates how single-precision real numbers are represented in memory.

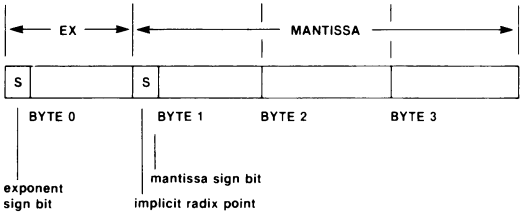


Figure 2-2 Machine Representation of Single-Precision Real

DOUBLE-PRECISION REAL CONSTANTS

Examples: 45D5, 23D-6, 8888888D-11

You can specify double-precision real in the constant by putting the letter D before the exponential part. Double-precision real numbers are stored in 8 bytes. Numbers are accurate to 16 decimal digits.

DOUBLE-PRECISION REAL VARIABLES

Examples: DBL#, X#, LGNO#

The pound sign (#) is the identifier for double-precision real variables. A double-precision real variable has 8 bytes. The exponent and sign are stored in the first byte. The exponential range is the same as single precision: -38 to + 38. The accuracy is 16 significant figures in double-precision real. The pound sign (#) identifier is placed after the variable name.

DEFDBL

Format: DEFDBL letter,|beginning_letter-ending_letter|
Examples: 10 DEFDBL Z, C-E
20 DEFDBL R

Variable names starting with letters identified by the DEFDBL statement are double-precision real. In the example above, CDE, Z, and R are all declared as double-precision. The variable name E1 would be a double-precision variable because the variable name begins with E.

Figure 2-3 illustrates how double-precision real numbers are represented in memory.

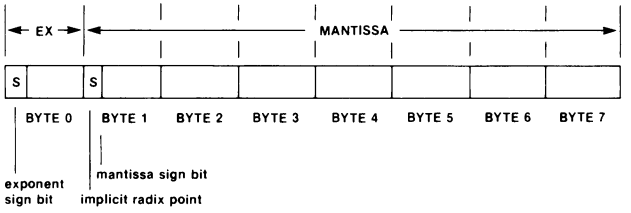


Figure 2-3 Machine Representation of Double-Precision Variable

HEXADECIMAL CONSTANTS

Examples: &76, &F3, &7B, &F3EB

It is often easier to specify locations and machine language code in hexadecimal (base 16) rather than decimal notation. By preceding a number with **&**, you declare it to be hexadecimal.

To jump to the machine language routine starting at hexadecimal location C305, you specify A = USR(&C305,0). A = PEEK (&5A61) will assign the contents of memory location 5A61 hex to the variable named A. Hexadecimal is useful in representing screen graphics—especially player-missile graphics.

Following is an equivalency table for decimal, hexadecimal, and binary numbers.

TABLE 2-1 DECIMAL, HEXADECIMAL, AND BINARY EQUIVALENTS

Decimal	Hexadecimal	Binary
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
10	A	1010
11	B	1011
12	C	1100
13	D	1101
14	E	1110
15	F	1111

STRINGS AND ARRAYS

STRING CONSTANTS

Examples: "AMOUNTS", "FILL IN NAME_____"

String constants are always enclosed in quotation marks. The string constant can be any length up to the maximum line length (120). Strings are composed of ANY keyboard characters: "!-$%&&"())00KJHGGFDS." A double-quotation mark ("") is also allowed. The double quotation mark ("") will give you a single quotation mark when the string is printed. The vertical bar (|) and the null character (♡) are used internally to denote the end of a string. Using one of these characters in a string will truncate the string at its position.

The following is an example of a string constant used in a print statement:

```
10 PRINT "Strings and %&'$ ""things""";
20 A$ = "STRING CONSTANTS ASSIGNED TO VARIABLE NAME"
30 PRINT A$
RUN RETURN
```

The example program will print: Strings and %&'$ "things"
STRING CONSTANTS ASSIGNED TO VARIABLE NAME

STRING VARIABLES

Examples: A$, NINT$, ADDRESS$

String variable names end with a dollar sign **$**. A string variable can be assigned a string up to the maximum line length. The double quotation mark ("") is a way of getting a single quotation mark (") within a string.
Examples of strings assigned to A$ include:

```
10 A$ = "a string"
20 A$ = "another ""string"""
```

DEFSTR

Format: DEFSTR letter,|beginning_letter-ending_letter|
Examples: 10 DEFSTR A, K-M, Z
20 DEFSTR F, J, I, O

A variable name can be defined as a string by declaring its starting letter in the DEFSTR statement. Strings can be up to the maximum line length. As in all variable name declarations, the tag identifier has precedence. A# and A% are their tag types (double precision and integer, respectively) even if their first letter is defined by DEFSTR.

Example Program:

```
10 DEFSTR A, M, Z
20 A = "Employee Name AMOUNT"
30 PRINT A
```

The example program will print the heading *Employee Name AMOUNT*.

ARRAYS

An array is a list of subscripted variables with the same variable name, such as A(0), A(1), A(2). Subscripts range from 0 to the dimensioned value. Figure 2-4 illustrates a 7-element array.

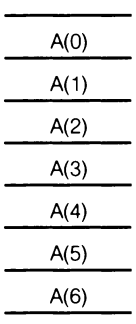


Figure 2-4 Example of an Array

You are allowed to use a maximum subscript of 10 in a list or array without having to use the dimension (DIM) statement. With the OPTION BASE default of zero (0), this provides 11 elements in an array without dimensioning.

For example, for an array called AN_ARRAY:

```
100 AN_ARRAY(1) = 55
120 AN_ARRAY(2) = 77
130 AN_ARRAY(3) = 93
140 AN_ARRAY(4) = 61
150 FOR X = 1 TO 4
160 PRINT AN_ARRAY(X)
170 NEXT
180 END
```

A multi-dimensional array is a collection of arrays. For example, a two-dimensional array contains two columns. Rows run horizontally and columns run vertically. Multi-dimensional arrays are stored by BASIC in row-major order. This means that all the elements of the first row are stored first, followed by all the elements of the second row, and so on. Figure 2-5 illustrates a 7 × 4 matrix.

	COLUMNS			
ROWS	M(0,0)	M(0,1)	M(0,2)	M(0,3)
	M(1,0)	M(1,1)	M(1,2)	M(1,3)
	M(2,0)	M(2,1)	M(2,2)	M(2,3)
	M(3,0)	M(3,1)	M(3,2)	M(3,3)
	M(4,0)	M(4,1)	M(4,2)	M(4,3)
	M(5,0)	M(5,1)	M(5,2)	M(5,3)
	M(6,0)	M(6,1)	M(6,2)	M(6,3)

Figure 2-5 Example of a Multidimensional Array

ARITHMETIC, RELATIONAL, AND LOGICAL OPERATORS

ARITHMETIC OPERATORS

The arithmetic operators are: (), =, −, ^, *, /, +, − (the first dash means negation, the last dash means subtraction). The arithmetic symbols can be mixed with the logical operators in creating expressions. The expression A/C > D*A is legal. The arithmetic expressions represent mathematical symbols. The * symbol represents multiplication. The ^ is used in ATARI Microsoft BASIC II to mean exponent. The order of precedence is:

SYMBOL	MEANING
()	Arithmetic within parentheses is evaluated first.
=	Equals sign.
-	Negative number. This is not subtraction but a negative sign in front of a number. Examples: -3, -A, -6.
^	Exponent.
*	Multiplication.
/	Division.
+	Addition.
-	Subtraction.

RELATIONAL OPERATORS

The relational operators are evaluated from left to right.

OPERATOR	MEANING
=	Equals. This is a true use of the equal sign. It asks if A = B. The B is not assigned to A.
< > or > <	Not equal. Evaluates whether two expressions are not equal.
<	Less than. A is less than B is represented by A < B.
>	Greater than. A is greater than B is represented by A > B.
> = or = >	Greater than or equal to. A is greater than or equal to B is represented by A > = B.
< = or = <	Less than or equal to. A is less than or equal to B is represented by A < = B.

Relational operators in strings (= , < > , < , > , < = , > =) can accomplish useful tasks. Alphabetical order can quickly be achieved by an algorithm using the expression A$ < B$. A match between names can be found by asking if A$ = B$. The string variables are evaluated as numbers in ATASCII code (for example, letter A is 65 while B is 66, so A < B is always true).

SYMBOL	MEANING
A$ < B$	True (nonzero) if A$ has a lower ATASCII code number than B$.

Sort Example:

```
100 INPUT A$,B$
120 IF A$ < B$ THEN 160
130 C$ = A$
140 A$ = B$
150 B$ = C$
160 PRINT A$, B$
170 END
```

To experiment, type any two word combinations and separate them by commas. The words will be sorted into alphabetical order using the example above. Thus, you will see that BILL comes before BILLY, and CAT comes before DOG.

LOGICAL OPERATORS

The logical operators have the following order of precedence:

OPERATOR	MEANING
NOT	The 8 bits of the number are complemented. If it is a binary 1, it becomes a 0 after this logical operation.
AND	The bits of the number are logically ANDed. Example: A AND B. If A is 1 and B is 1, the result is 1. If A is 1 and B is 0, the result is 0. If A is 0 and B is 1, the result is 0. If A is 0 and B is 0, the result is 0.
OR	The bits of the number are logically ORed. Example: A OR B. If A is 1 and B is 1, the result is 1. If A is 1 and B is 0, the result is 1. If A is 0 and B is 1, the result is 1. If A is 0 and B is 0, the result is 0.
XOR	The bits of the number are logically eXclusive ORed. Example: A XOR B. If A is 1 and B is 1, the result is 0. If A is 1 and B is 0, the result is 1. If A is 0 and B is 1, then the result is 1. If A is 0 and B is 0, then the result is 0.

The logical operators can be used with string (A$) variables. Read "String Functions" in Section 5.

Note: The relational operators and logical operators can be combined to form expressions. The relational operators have precedence over logical operators. For example: A > B AND C < D is an expression. The greater than (>) and less than (<) symbols are considered first, then the AND is evaluated. If the relationship is true, a nonzero number results. If the relationship is not true, then zero is the result. Nonzero is true and zero is false. In an IF statement, this evaluation determines what happens next. The ELSE or the next line number is taken when the expression formed with operators is false.

3 PROGRAM COMMANDS

AUTO
(Available only with the extension diskette)

This section describes the commands usually entered in the direct mode.

Format: AUTO |n,i|
Examples: AUTO 200,20
AUTO

AUTO numbers your lines automatically. If you do not specify n,i (starting number, increment) you get line numbers starting at 100 with an increment of 10. Use AUTO when you start writing a program. Type **AUTO**, then type a starting line number, a comma, and the amount you want the line numbers to increase. Next, press **RETURN** to start the AUTO numbering. You will see a new line number printed automatically after you type a statement and press **RETURN**. To stop AUTO, press **RETURN** by itself without typing a statement. AUTO can also be stopped by pressing the **BREAK** key.
Example Program:

```
AUTO 300,20 RETURN          Starts numbering at 300 and increments by 20
300 PRINT "THIS SHOWS HOW"
320 PRINT "AUTO NUMBERING"
340 PRINT "WORKS"
360 RETURN
■
```

Note: If there is an existing line at the new line number being generated, the existing line will be displayed on your television screen.

CLOAD

Format: CLOAD
Examples: CLOAD
440 CLOAD

Use CLOAD to load a program from cassette tape into RAM for execution. When you enter **CLOAD** and press **RETURN**, the in-cabinet buzzer sounds. Position the tape to the beginning of the program, using the tape counter as a guide, and press **PLAY** on the ATARI 410™ Program Recorder. Then press the **RETURN** key again. Specific instructions to CLOAD a program are contained in the *ATARI 410 Program Recorder Operator's Manual.*

CONT

Format: CONT
Example: CONT

CONT continues program execution from the point at which it was interrupted by either STOP, the **BREAK** key, or a program error. This instruction is often useful in debugging a program. A breakpoint can be set using the STOP statement. You can check variables at the point where execution stops by using PRINT variable_name in the direct mode (without a line number). Then resume the program by using the CONT statement.

CSAVE

Format: CSAVE
Examples: CSAVE
330 CSAVE

CSAVE saves a RAM-resident program onto cassette tape. CSAVE saves the tokenized (compacted) version of the program. As you enter **CSAVE** and press **RETURN**, the in-cabinet buzzer sounds twice signaling you to press **PLAY** and **RECORD** on the program recorder. Then press **RETURN** again. Do not, however, press these buttons until the tape has been positioned. Saving a program with this command is speedier than with SAVE"C:" because short interrecord gaps are used. Use SAVE"C:" with LOAD"C:" or CSAVE with CLOAD but do not mix these paired statements — SAVE"C:" with CLOAD will give you an error message.

DEL
(Available only with the extension diskette)

Format: DEL n-m
Examples: DEL 450 -
DEL 250 - 350
DEL - 250

DEL deletes program statements currently in memory. With the DEL command you can delete just one statement or as many as you wish. A hyphen is used to specify the range of statements:

DEL n Deletes only the statement n (where n is a statement number).

DEL -m Deletion starts with the first statement in the program and stops with statement m. Statement m is deleted.

DEL n- Deletion starts with statement number n and continues to the last statement number in the program.

DEL n-m Deletion starts with n and ends with m. Both statements n and m are deleted.

Example Program:
100 PRINT "AN EXAMPLE OF"
120 PRINT "HOW THE DELETE"
130 PRINT "COMMAND WORKS"

DEL 120- RETURN

Only statement 100 is left in memory.

LIST RETURN

100 PRINT "AN EXAMPLE OF"

If you want to delete a single statement from a program, simply type the statement number and press **RETURN**.

Example Program:
110 FOR X = 1 TO 5000:NEXT

110 RETURN

Note: If you try to use DEL in deferred mode, your program stops after the deletion of line numbers.

DOS

Format: DOS
Example: DOS

The DOS command lets you leave BASIC and enter the Disk Operating System menu. This makes available all of the DOS menu items on programs and data stored on diskette. To return to ATARI Microsoft BASIC II select the B option in the DOS menu. This method of entering DOS erases the BASIC program currently in memory unless you have a **MEM.SAV** file on your diskette. (Refer to the *Atari Disk Operating System II Manual.*)

Note: If you do not have a disk drive, typing DOS will take you to the memo pad.

KILL

Format: KILL "device:program_name"
Example: KILL "D:PROG1.BAS"

KILL deletes the named program from a device.

LIST

Format: LIST|"device:program_name"| |m-n|
Examples: 100 LIST
150 LIST "C:
120 LIST "P:" 10-40
100 LIST "D:GRAFX.BAS
110 LIST 100-200
100 LIST -300

LIST writes program statements currently in memory onto the television screen or another device. If "device:program_name" is present, the program statement currently in memory is written onto the specified device.

Legal device names include: D: (for disk), C: (for cassette), P: (for printer). If you do not use LIST with a device name, the screen (E:) is assumed. The program name can be any name less than or equal to eight characters with a three-character extension.

When you list programs on the screen, it is often convenient to freeze the list while it is scrolling. To freeze a listing, press both **CTRL** and 1 at the same time. To continue the listing, again press **CTRL** and 1 at the same time.

With the LIST command you can list one program line or as many as you wish. A hyphen (-) is used to specify the range of statements:

LIST Lists the whole program from lowest line number to the highest.

LIST n Lists only the statement n (where n is a statement number).

LIST -m Listing starts with the first statement in the program and stops listing with statement m. Statement m is listed.

LIST n- Listing starts with statement number n and continues to the last statement number in the program.

LIST n-m Listing starts with n and ends with m. Both statements n and m are included in the listing.

Example Program (note that REM indicates a remark that is not executed—see REM in Section 4):

```
100 REM Example of the list
110 REM Command
120 PRINT "SHOWS WHICH STATEMENTS"
130 PRINT "OR GROUP OF STATEMENTS"
140 PRINT "GET LISTED"
```

LIST 110-130 RETURN

Microsoft BASIC II displays the following:

```
110 REM Command
120 PRINT "SHOWS WHICH STATEMENTS"
130 PRINT "OR GROUP OF STATEMENTS"
```

Example of LIST used in deferred mode:

```
10 COUNT = 1
20 COUNT = COUNT + 1
30 PRINT COUNT
40 IF COUNT <> 30 THEN 20
50 LIST
```

Use LIST to list a program on a printer. This is done in direct mode.

```
LIST"P:"
```

Use LIST to list a program in untokenized ASCII form onto a diskette. To list to diskette use:

```
LIST"D:name.ext"
```

Use LOAD when you are entering untokenized (listed) programs into your computer's memory. LOAD can be used to enter programs that have been listed or saved to cassette or diskette.

LOAD

Format: LOAD "device:program_name"

Examples: LOAD "D:EXAMPLE"

```
110 LOAD "C:"
```

LOAD "device:program_name" replaces the program in memory with the one located on the specified **device**. A disk drive or cassette can be specified for "device:". Use LOAD "C:" to load data or listed cassette files. For cassette programs that have been previously saved with CSAVE, use CLOAD. For diskette files, use "D:program_name" for listed or saved programs. (See also MERGE.)

LOCK

Format: LOCK "device:file_name"
Example: LOCK "D:CHECKBK"

LOCK offers a measure of protection against accidental erasure of files. Once a file is locked, it cannot be rewritten, deleted, or renamed.

MERGE

Format: MERGE "device:program_name"
Example: MERGE "D:STOCK.BAS"

Use MERGE to merge the program stored at "device:program_name" with the program in memory. Only listed programs can be merged. If duplicate line numbers are encountered, the line on "device:program_name" replaces the one in memory. An error 136 (end of file) is given at the end of the merge operation.

Example Program (see explanation of REM in Section 4):

```
100 REM THIS PROGRAM
120 REM MERGING
130 REM PROGRAM
  LIST "D:STOCK.BAS"
110 REM IS AN EXAMPLE
115 REM TO SHOW A PROGRAM
125 REM ANOTHER
  MERGE "D:STOCK.BAS"
  LIST
100 REM THIS PROGRAM
110 REM IS AN EXAMPLE
115 REM TO SHOW A PROGRAM
120 REM MERGING
125 REM ANOTHER
130 REM PROGRAM
```

NAME...TO

(Available only with the extension diskette)

Format: NAME "device:program_name_1" TO "program_name_2"
Example: NAME "D:BALANCE" TO "CHECKBK"

NAME gives a new name to a file. The device must be given for the old program, but only the new program name enclosed in quotes is required following the word TO.

NEW

Format: NEW
Examples: NEW
100 IF CODE <>642 THEN NEW

NEW clears the program currently in memory and allows you to enter a new program. The NEW command does not destroy the time stored under the keyword TIME$. All variables are cleared to zero and all strings are nulled when NEW is executed.

RENUM
(Available only with the extension diskette)

Format: RENUM |m, n, i|
Example: RENUM 10,100,10
m = The new line number to be applied to the first renumbered statement.
n = The first old line number to be renumbered.
i = The increment between new generated line numbers.

RENUM gives new line numbers to specified lines of a program. The default of RENUM is 10, 0, 10.

RENUM changes all references following GOTO, GOSUB, THEN, ON...GOTO, ON...GOSUB, and ERROR statements to reflect the new line numbers.

Note: RENUM cannot be used to change the order of program lines. For example, RENUM 15, 30 would not be allowed when the program has three lines numbered 10, 20, and 30. Numbers cannot be created higher than 63999.
Examples:

RENUM	Renumbers the entire program. The first new line number will be 10. Lines will increment by 10.
RENUM 10,100	The old program line number 100 will be renumbered 10. Lines increment by 10 (the default is 10).
RENUM 800,900,20	Renumbers lines from 900 to the end of the program. Line 900 now is 800. The increment is 20.

RENUM 300, 140, 20 gives number 300 to line 140 when it is encountered . The increment is 20.

BEFORE	AFTER
100	100
110	110
120	120
130	130
140	300
150	320
160	340
170	360

RUN

Format: RUN |"device:program_name"| |optional_starting_line_number|
Examples: RUN
RUN 120
200 RUN "D:TEST.BAS"
110 RUN 200

RUN without a line number starts executing your program with the lowest numbered statement. RUN initializes all numeric variables to zero and nulls string variables before executing the first statement in the program.

RUN can be used in the deferred mode (with a line number). It can also be used to enter a program from diskette or cassette. However, when RUN is used to run a program on diskette or cassette (for example, RUN "D:SHAPES"), it cannot be used with "optional_starting_line_number," which can only be used to run programs that are already in memory. RUN can be used to run tokenized (saved with the SAVE instruction) programs only.
Example: RUN 250
Example Program: 200 RUN "D:TEST

When statement line number 200 is executed, it will run the program called TEST.

SAVE

Format: SAVE "device:program_name"
Example: SAVE "D:GAME.BAS"

SAVE copies the program in memory onto the file named by *program_name*. Legal devices are D: (for disk), C: (for cassette). For example, the command SAVE "D:TEMP.BAS" will save the program currently in memory onto diskette. The program is recorded in "tokenized" form onto tape or diskette.
Example:
SAVE "D:PROGRAM" Saves the program in memory on the diskette file named PROGRAM.

SAVE "C:" Saves the program on cassette. (No filename is required.)

Note: A program saved with the filename of AUTORUN.AMB is considered an autoboot program, i.e., it will be executed immediately when the system is powered on.

SAVE...LOCK

Format: SAVE "device:program_name" LOCK
Example: SAVE "D:PROGRAM.EXA" LOCK

SAVE "device:program_name" LOCK saves a program onto tape or diskette and encodes it so that it cannot be edited, listed, merged, examined, or modified. LOCK is used to prevent program tampering and theft.

TROFF
(Available only with the extension diskette)

Format: TROFF
Example: 770 TROFF

This command turns off the trace mechanism (see TRON). You may use TROFF in direct or deferred mode.

TRON
(Available only with the extension diskette)

Format: TRON
Examples: TRON
550 TRON

This command turns on the trace mechanism. When TRON is issued, the number of each line encountered is displayed on your television screen before it is executed. You may use TRON in direct or deferred mode.

UNLOCK

Format: UNLOCK "device:program_name"
Example: UNLOCK "D:GAME1.BAS"

The UNLOCK statement restores a file so that you can rewrite, delete, or rename it. It will not unlock a file that has been SAVED with the LOCK option.

VERIFY
(Available only with the extension diskette)

Format: VERIFY "device:program_name"
Examples: VERIFY "D:BIO.BAS"
VERIFY "C:

VERIFY compares the program in memory with the one named by "device:program_name." If the two programs are not identical, you get a FILE MISMATCH ERROR.

4 PROGRAM STATEMENTS

AFTER

Format: AFTER (time_in_1/60_of_a_sec) |GOTO| line_number
Example: 100 AFTER (266) GOTO 220

When AFTER (...) is executed, a time count starts from 0 up to the indicated number of 1/60 of a second (called jiffies). When the time is up, program execution transfers to "line_number." AFTER can be placed anywhere in a program but it must be executed in order to start its count. A time period up to 24 hours is allowed.

When RUN, STOP, or END is executed the AFTER statement jiffie count is reset.

Example Program:

```
10 CLS:AFTER (300) GOTO 70
20 PRINT "YOU HAVE 5 SECONDS TO PRESS A KEY, ":PRINT "ANY KEY."
30 IF INKEY$ = "" THEN 30
40 PRINT "THANK YOU"
50 CLEAR STACK
60 END
70 PRINT "TIME'S UP!";
80 RESUME 50
```

CLEAR

Format: CLEAR
Examples: CLEAR
550 CLEAR

CLEAR zeros all variables and arrays, and nulls all strings. If an array is needed after a CLEAR command, it must be redimensioned.

CLEAR STACK

Format: CLEAR STACK
Example: 100 CLEAR STACK

CLEAR STACK clears all current time entries. CLEAR STACK is a way to abort the AFTER statement. If certain conditions are met in a program, you may wish to cancel the AFTER statement.

Example Program:

```
10 AFTER (120) GOTO 30
20 CLEAR STACK
25 STOP
30 PRINT "YOUR TURN IS OVER"
40 STOP
```

CLOSE

Format: CLOSE #iocb
Example: CLOSE #2

Use CLOSE after file operations are completed. The # sign is mandatory and the number itself identifies the IOCB.

Mandatory symbol.
iocb The number of a previously opened IOCB.

COMMON

Formats: COMMON variable_name|variable_name|
COMMON ALL
Examples: 110 COMMON I, J, A$, H%, DEC
100 COMMON ALL

Use COMMON to keep variable values across programs. COMMON makes variables in two programs share the same name and values. If you name a variable COUNT in one short program and join that program with another program that has COUNT as a variable, the program considers the COUNTs to be different variables. The COMMON statement says that you want both COUNTs to be considered the same variable. COMMON ALL keeps all previous variable values the same across the new program run.

Example Program:

```
100 COMMON X
110 X=4
120 RUN "D:PROG2"
```

BREAK
PRINT X **RETURN**

The value of X when line 120 executes PROG2 is 4. If there is already a variable named X in PROG2, X gets its value from the COMMON statement in the new program.

DEF
(Available only with the extension diskette)

Format: DEF function_name (variable|,variable|) = function_definition
Example: 150 DEF MULT(J,K) = J*K

User-defined functions in the form DEF A(X) = X∧2, where A(X) represents the value of X squared, can be used throughout a program as if they were part of the BASIC language itself. Normally a user-defined function is placed at the beginning of a program. The user-defined function can occupy no more than a single program line. String-defined functions are allowed. If the defined function is a string variable name, then the defined expression must evaluate to a string result. One or more parameters can be defined. Thus, DEF S$(A$,B$) = A$ + B$ is legal.

Example Programs:

```
 5 !DEFINES AVERAGING FUNCTION
10 DEF AVG(X,Y) = (X + Y)/2
20 PRINT AVG(25,35)
30 END
```

RUN **RETURN**

30

Example Programs:

```
100 !DETECT PADDLE POSITION
110 DEF PADDLE(X) = PEEK(624 + X)
120 PRINT PADDLE(0)
130 GOTO 120
```

```
100 !DETECT JOYSTICK BUTTON
110 DEF STRIG(X) = PEEK(644 + X)
120 IF STRIG(0) THEN 420 ELSE PRINT"BANG!"
130 GOTO 420
```

Note: DEF is not allowed in the direct mode.

DIM

Formats: DIM arithmetic_variable_name (number_of_elements), |list|
DIM string_variable_name$ (number_of_elements), |list|

Examples: 10 DIM A$ (35), TOTAMT (50)

The DIM statement tells the computer the number of elements you plan to have in an array. If you enter more data elements into an array than you have allowed for in a dimension statement, you get an error message.

The simplest array is the one-dimensional array. Let's say you have 26 students in a class. You can record a numeric test score for each student by dimensioning:

```
10 OPTION BASE 1
20 DIM SCORE(26)
30 SCORE (1) = 55
40 SCORE (2) = 86
50 PRINT SCORE (1), SCORE (2)
RUN
```

Notice that the OPTION BASE statement begins the array subscripting with 1, thus SCORE (1) stores the numeric score of the first student. OPTION BASE 0 allows you to begin subscripting with the number 0.

ATARI Microsoft BASIC II allows you to have up to 255 array dimensions. Three-dimensional arrays allow you to make complex calculations easily.

Example Programs:

```
110 X = 10:Y = 10:Z = 10
120 DIM BOXES(X,Y,Z)
```

```
10 REM Eleven items in array
20 DIM GROUP1 (10)
30 For I = 0 to 10: GROUP1(I) = I:PRINT GROUP1(I):NEXT
40 END
```

```
 5 REM Ten items in an array
10 OPTION BASE1
20 DIM GROUP2 (10)
30 FOR I = 1 TO 10:GROUP2(I):PRINT GROUP2(I):NEXT
40 END
```

END

Format: END
Example: 990 END

END halts the execution of a program and is usually the last statement in a program. When END terminates a program, the prompt character appears on the screen. In ATARI Microsoft BASIC II, it is not necessary to end a program with the END statement.

ERROR

Format: ERROR error_code
Example: 640 ERROR 162

ERROR followed by an error code forces BASIC to evaluate an error of the specified error code type. Forcing an error to occur is a technique used to test how the program behaves when you make a mistake. A complete listing of error codes is given in Appendix O. You can force both system errors and BASIC errors.

FOR...TO...STEP/NEXT

Format: FOR starting_variable = starting_value TO ending-value STEP |increment| value
Examples: 10 FOR X = 1 TO 500 STEP 3
150 FOR Y = 20 TO 12 STEP -2
30 FOR COUNTER = 1 TO 250

FOR and NEXT go together to repeatedly execute a set of instructions until a variable reaches a certain value. The variable begins with the starting value and increases by the amount of the increment value each time until the ending value is exceeded.

FOR/NEXT determines how many times statements between the line numbers of the FOR...TO...STEP and the NEXT are executed repeatedly. If STEP is omitted, it is assumed to be 1. STEP can be a negative number or decimal fraction. The example program prints 30 numbers with their square roots.

Example Program:

```
100 FOR X = 1 TO 30
110 PRINT X, SQR(X)
120 NEXT
```

GET

Format: GET#iocb, |AT(sector,byte);| variable_name
Examples: 200 GET #1, X
330 GET #3, AT(8,2);J,K,L

GET reads a byte (value from 0-255) from a file designated by the #iocb and then stores the byte in the "variable_name."

The example program requires a file called "MYFILE" to exist on the disk drive. Use the PUT example program *before* using the program.

Example Program:
110 OPEN #1, "D:MYFILE" INPUT
120 GET #1, A,B,C
130 CLOSE #1
140 PRINT A,B,C

Note: GET is not allowed in immediate mode.

GOSUB/RETURN

Format: GOSUB line_number
Example: 330 GOSUB 150

GOSUB causes the line indicated by "line_number" to be executed. A RETURN statement marks the end of the subroutine and returns execution to the statement after the GOSUB statement.

GOTO

Format: GOTO line_number
Example: 10 GOTO 110

GOTO tells the system which line number is to be executed next. Normally, statements are executed in order from the lowest to highest number, but GOTO changes this order. GOTO causes a branch in the program to the line number following GOTO.
Example: GOTO 55

Since this statement does not have a line number, it starts immediate execution of the program in memory starting at line number 55.

100 PRINT "THIS IS ENDLESS"
120 GOTO 100
RUN **RETURN**

This program causes endless branching to line number 100. Thus, the television screen quickly fills up with THIS IS ENDLESS. Press **BREAK** to stop the program.

IF...THEN

Format: IF test_condition THEN goto_line_number or statement
Examples: 10 IF A = B THEN 290
20 IF J >Y AND J< V THEN PRINT "OUT OF STATE TAX"

If the result of the test condition is true, the next statement executed is the one indicated by "goto_line_number." A test is made with the relational or mathematical operators. The test can be made on numbers or strings. The words GOTO after THEN are optional. If the test condition is false, the execution goes to the next numbered line in the program.
Example Program:
160 IF A_NUMBER > ANOTHER_NUMBER THEN 300
200 PRINT "ANOTHER NUMBER IS LARGER"
250 STOP
300 PRINT "A NUMBER IS LARGER"
450 END

IF...THEN...ELSE

Format: IF test_condition THEN goto_line_number or statement ELSE goto_line_number or statement
Example: 250 IF R < Y THEN 450 ELSE 200

This is the same as IF...THEN except that execution passes to the ELSE clause when the test condition is untrue.

INPUT

Format: INPUT|#iocb| |"prompt_string";|variable_name|,var_name|
Examples: 120 INPUT "TYPE YOUR NAME";A$
350 INPUT "ACCOUNT NO., NAME";NUM,B$

INPUT lets you communicate with a program by typing on the computer keyboard. You are also allowed to print character strings with the INPUT statement. This lets you write prompts for the user such as TYPE YOUR NAME. The typed characters are as signed to the variable names when you press the **RETURN** key or type a comma. The INPUT statement temporarily stops the program until your keyboard input is complete. The INPUT statement automatically puts a question mark on the television screen.

Note: Commas are not allowed when input is entered on the keyboard. INPUT is not allowed in the direct mode.

INPUT...AT

Format: INPUT|#iocb,| AT (s,b) variable_name
Example: 300 INPUT #5, AT (9, 7)X

If a disk drive has been opened as INPUT and assigned an IOCB#, then it can be used to input data. The input from the device is read AT(sector,byte) and assigned a variable name. INPUT#6, AT(x,y)X can be used to read a specific screen location.

LET

Formats: |LET| variable_name = |arithmetic_expression| or |string_expression|
variable_name = |arithmetic_expression| or |string_expression|
Examples: 100 LET COUNTER = 55
120 D = 598

LET assigns a number to a variable name. The equal sign in the LET statement means "assign," not "equal to" in the mathematical sense. For example, LET V = 9, assigns a value of 9 to a variable named V. The number on the right side of the equal sign can be an expression composed of many mathematical symbols and variable names. Thus, LET V = (X + Y-9)/(W*Z) is a legal statement.

The word LET is optional. All that is necessary for assignment is the equal sign. Thus,

```
100 LET THIS = NUMBER * 5
```

is the same as:

```
100 THIS = NUMBER * 5
```

LINE INPUT

Format: LINE INPUT|#iocb| |"prompt_string";| string_variable_name$
Example: 190 LINE INPUT ANS$

An entire line is input from the keyboard. Commas, colons, semicolons, and other delimiters are allowed. Mark the end of the line by pressing **RETURN**.
Example Program:

```
100 LINE INPUT "WHAT IS YOUR NAME?"; N$
120 PRINT N$
130 END
```

LINE INPUT...AT

Formats: LINE INPUT #iocb,AT(s,b)|"prompt_string"|variable_name
Example: 300 LINE INPUT #5, AT(9,7)X

If a disk drive has been opened as LINE INPUT and assigned an IOCB#, then it can be used to input data. The input from the device is read AT (sector, byte) and assigned a variable name. LINE INPUT#6, AT(x,y);X can be used to read a specific screen location.

MOVE

Format: MOVE from_address, to_address, no._of_bytes
Example: 20 MOVE MADDR1, MADDR2, 9

The MOVE statement moves bytes of memory from one area of memory to another.The first location of the original memory block is given by the first numeric expression (from_address) and the first location of the destination block is given by the second numeric expression (to_address). The third numeric expression specifies how many bytes are to be moved. The order of movement is such that the contents of the block of data are not changed by the move. MOVE's primary use is in player-missile graphics.

Example: MOVE 55,222,5

Five bytes with a starting low address at 55 (i.e., 55-60) will be moved to location 222-226.

NEXT

Format: NEXT |variable_name|
Examples: 30 NEXT J,I
40 NEXT VB
120 NEXT

NEXT transfers execution back to the FOR...TO line number until the TO count is exceeded. NEXT does not need to be followed by a variable name in ATARI Microsoft BASIC II. When NEXT is not followed by a variable name, the execution is transferred back to the unterminated FOR...TO statement.

Example Program:
100 FOR X = 10 TO 100 STEP 10
110 PRINT X
120 NEXT
130 END

RUN **RETURN**

Then you see displayed:
10
20
30
40
50
60
70
80
90
100

Two or more "starting-variables" can be combined on the same NEXT line with commas.
Example Program:
100 FOR X = 1 TO 20
110 FOR Y = 1 TO 20
120 FOR Z = 1 TO 20
130 NEXT Z,Y,X

NOTE
(Available only with the extension diskette)

Format: NOTE #iocb,variable_name,variable_name
Example: 120 NOTE 4,I,J

Use NOTE to store the current diskette sector number in the first "variable_name" and the current byte number within **byte**. This is the current read or write position in the specified file where the next byte to be read or written is located.

ON ERROR

Format: ON ERROR |GOTO| line_number
Example: ON ERROR 550

Program execution normally halts when an error is found and an error message prints on the television screen. ON ERROR traps the error and forces execution of the program to go to a specific line number.

The ON ERROR statement must be placed before the error actually occurs in order to transfer execution to the specified line.

To recover normal execution of the program, you must use the RESUME statement. The RESUME statement transfers execution back into the program.

When RUN, STOP, or END is executed, the ON ERROR statement is nullified until the next ON ERROR statement.

Example Program:
```
10 ON ERROR 1000
20 PRINT #3, "LINE"
30 STOP
1000 PRINT "DEVICE NOT OPENED YET"
1010 STOP
1020 RESUME
```

The ON ERROR line_number statement can be disabled by the statement: ON ERROR GOTO 0. If you disable the effect of ON ERROR within the error-handling routine itself, the current error is processed in the normal way.

ON...GOSUB/RETURN

Format: ON arithmetic_expression GOSUB line_number_1, line_number_2, line_number_3
Example: 220 ON X GOSUB 440, 500, 700

ON...GOSUB determines which subroutine is to be executed next. It does this by finding the number represented by the "arithmetic_expression." If the number is a 1 then execution passes to "line_number_1." If the number is a 2, execution passes to "line_number_2," or if the number is a 3, execution passes to line_number_3, etc.
Example Program:
```
100 INPUT "TYPE A NUMBER (1-4)"; X
110 ON X GOSUB 130, 140, 150, 170
120 GOTO 100
130 PRINT "FIRST CALL - X = 1":RETURN
140 PRINT "SECOND CALL - X = 2":RETURN
150 PRINT "THIRD CALL - X = 3":RETURN
160 PRINT "CAN'T GET HERE": REM THIS IS NOT IN THE ON . . . GOSUB LINE
170 PRINT "END THE PROGRAM": END
```

ON...GOTO

Format: ON arithmetic_expression GOTO line_number_1, line_number_2, line_number_3
Example: 400 ON X GOTO 550, 750, 990

ON...GOTO determines which line is executed next. It does this by finding the number represented by the "arithmetic_expression" and if the number is a 1, control passes to "line_number_1." If the number is a 2, control passes to "line_number_2." If the number is a 3, control passes to "line_number_3," and so on.

OPEN

Format: OPEN #iocb, "device:program_name" file_access
Examples: 130 OPEN #4, "K:" INPUT
100 OPEN #3, "P:" OUTPUT
150 OPEN #4, "D:PROG.SAV" INPUT
120 OPEN #2, "D:GRAPH1.BAS" UPDATE
110 OPEN #5, "D:PROG.BAS" APPEND

#	Mandatory character entered by user.
iocb,	Input/output control block (IOCB). Choose a number from 1 to 7 to identify a file and its file access. You must have a pound sign (#) followed by an IOCB number (1-7) and a comma. (Refer to the *ATARI Home Computer System Technical Reference Notes* for a detailed explanation of IOCB.)
"device:program_name"	Specifies the device and the name of the program. Devices are D: (disk), P: (printer), E: (screen editor), K: (keyboard), C: (cassette), S: (television monitor), and R: (RS 232-C). When you use D: your program name follows the colon. The name of your program can be up to eight characters long and have a three-character extension. Program names must begin with an alphabetic character. At the beginning of this section you will find a complete description of the device codes (K:, P:, C:, D:, E:, S:, R:).
file_access	Tells the type of operation: INPUT = input operation OUTPUT = output operation UPDATE = input and output operation APPEND = allows you to add onto the end of a file

The idea behind the OPEN statement is to associate a number (the IOCB#) with the name of a file and its access characteristics. After the OPEN#n statement is encountered in a program, you can use PRINT#2, INPUT#3, NOTE#5, STATUS#2, GET#4, and PUT#4. That is, you can use the IOCB# as an identifier.

The OPEN#n and PRINT#n statements now substitute for LPRINT (LINE PRINTING):

```
100 OPEN#3, "P:" OUTPUT
110 PRINT#3, "THIS IS A PRINTER TEST"
120 CLOSE#3
```

The following IOCB identifiers have preassigned uses:

- #0 is used for INPUT and OUTPUT to E:, the screen editor.
- #6 is used for INPUT and OUTPUT to S:, in all graphics modes.

An example of the use of IOCB #6 is:

```
100 GRAPHICS 2
110 PRINT #6, AT(5,5); "SCREEN PRINT TEST"
```

IOCBs #1 through #5 (and IOCB #7) can be used freely, but the preassigned IOCBs should be avoided.

OPTION BASE

Formats: OPTION BASE 0 (Default)
OPTION BASE 1
Examples: 150 OPTION BASE 1
200 DIM Z (25,25,25)!array element subscripts nos. 1-25

OPTION BASE declares that array subscript numbering starts with 0 or 1. The OPTION BASE (0/1) statement should be the first executable statement in a program. If the OPTION BASE statement is omitted, lists' and arrays' subscript numbering starts at 0.
Example Program:

```
100 REM DEMONSTRATES OPTION BASE 1 STATEMENT
110 OPTION BASE 1
120 DIM ARRAY (15,15)
150 READ ARRAY (1,1), ARRAY (2,2), ARRAY (15,15)
165 DATA 32,33,34
180 PRINT ARRAY (1,1), ARRAY (2,2), ARRAY (15,15)
190 END
```

OPTION CHR1, OPTION CHR2, OPTION CHR0

Formats: OPTION CHR1
OPTION CHR2
OPTION CHR0
Examples: 110 OPTION CHR1
120 OPTION CHR2
130 OPTION CHR0

OPTION CHR1 reserves 1024 bytes in memory for character data. OPTION CHR2 reserves 512 bytes in memory for character data. OPTION CHR0 releases all OPTION CHR reservations.

Use OPTION CHR1 or OPTION CHR2 to reserve memory for a RAM character set. You can MOVE the ROM character set into the new RAM area you have reserved or you can define a totally new character set. VARPTR(CHR1) or VARPTR(CHR2) points to the starting address. It is necessary to POKE a new starting address into CHBAS (see Table E-2 in Appendix K). This can be done by determining the page to which VARPTR(CHR1) or VARPTR(CHR2) is pointing. One way to determine and POKE a new CHBAS is:

```
300 CHBAS = &2F4
310 ADDR% = VARPTR(CHR1)
320 POKE CHBAS,((ADDR%/256)AND &FF)
```

The GRAPHICS instruction (see Section 6) must always precede the OPTION CHRn statement. This is because the computer must first know the graphics mode before you reserve space.

This procedure masks for the most significant byte (MSB) of the VARPTR memory address and POKEs that MSB into CHBAS so you switch to the new character set. See Appendix C for an example of redefining the character set.

OPTION PLM1, OPTION PLM2, OPTION PLM0

Formats: OPTION PLM1
OPTION PLM2
OPTION PLM0
Examples: 100 OPTION PLM1
100 OPTION PLM2
700 OPTION PLM0

OPTION PLM1 reserves 1280 bytes in memory for player-missiles (single-line resolution). OPTION PLM2 reserves 640 bytes in memory for player-missiles (double-line resolution). OPTION PLM0 releases all OPTION PLM reservations.

The GRAPHICS instruction (see Section 6) must always precede the OPTION PLMn statement. This is because the computer must first know the graphics mode before you reserve space.

Use OPTION PLM1 or OPTION PLM2 to reserve player-missile memory, clear the memory, and set PMBASE (see Table E-2 in Appendix L). You do not need to worry about the proper memory area to place player-missiles when you use the OPTION PLM statements. To find the exact memory location of the starting byte of your missiles, use VARPTR(PLM1) or VARPTR(PLM2).

You must POKE decimal location 53277 with decimal 3 in order to enable player-missile graphics. You must also POKE decimal location 559 with decimal 62 for single-line resolution or decimal 46 for double-line resolution. See Section 7 for an example of player-missile graphics.

OPTION RESERVE

Format: OPTION RESERVE n
Example: 300 OPTION RESERVE 24

In the OPTION RESERVE n statement, n is a number representing the number of bytes reserved. For example, OPTION RESERVE 24 reserves 24 bytes. VARPTR(RESERVE) can be used to tell you the starting address of the 24 bytes in OPTION RESERVE 24. This statement allows you to reserve bytes for machine code or for another purpose.

PRINT

Formats: PRINT "string_constant"
? "string_constant", variable_name
PRINT variable_name_1, variable_name_2, . . . variable_name_n
Examples: 100 PRINT "SORTING PROGRAM";A$,X
500 ?#6, "ENTERING DUNGEON" !Print for GRAPHICS 1 and 2

PRINT puts string constants, string variables, or numeric variables on the television screen when executed. The PRINT statement leaves a blank line when executed alone. The question mark symbol (?) means the same thing as the word PRINT.

Example Program:

```
100 PRINT "SKIP A LINE"
120 PRINT
125 REM NOTE USE OF "" TO PRINT A QUOTATION
130 ANOTHER_LINE$ = "PRINT ""ANOTHER"" LINE"
140 ? ANOTHER_LINE$
150 END
```

Line 120 leaves a blank line when this program is run:

```
RUN RETURN

SKIP A LINE

PRINT "ANOTHER" LINE
```

String constants, string variables, and numeric variables all print on the same line when the line construction includes a comma or semicolon.

It is not necessary to use a closing quotation if you wish to print a string constant on your television screen:

```
100 PRINT "NO CLOSING QUOTE HERE

RUN RETURN
NO CLOSING QUOTE HERE
```

PRINT . . . AT

Formats: PRINT #iocb, AT(A,B)x,y
PRINT #6, AT(x,y) "string_constant";variable_name

PRINT . . . AT will print at a particular sector and byte if the disk drive has been opened as OUTPUT (see OPEN statement). The AT clause is quite versatile. If the device being addressed is a disk drive, AT(s,b) refers to the sector, byte. However, if the device being addressed is the screen, as in PRINT or PRINT#6, then the AT(x,y) refers to the x,y screen position.

An example of printing to a disk drive:

```
100 OPEN#3, "D:TEST.DAT" OUTPUT
110 X = 5
120 PRINT#3, AT(7,1)"TEST";X
130 CLOSE#3
```

Note: The sector and byte location has to be previously assigned to the file opened before you can successfully write to it.

An example of printing to a screen location:

```
100 GRAPHICS 1
110 PRINT#6, AT(3,3)"PRINTS ON SCREEN"
```

PRINT. . .SPC

Format: SPC(n)
Example: 10 PRINT TAB (5);"XYZ";SPC (7);"SEVEN SPACES RIGHT OF XYZ"

SPC puts spaces between variables and constants in a line to be printed. SPC counts spaces from where the last character was printed.

PRINT. . .TAB

Format: TAB(n)
Example: 120 PRINT TAB(5);"PRINT STARTS 5 SPACES OVER"

TAB moves the cursor over the number of positions specified within the parentheses. This statement is used with PRINT to move characters over a number of tabbed spaces. TAB always counts spaces from the first position on the left-hand margin.
Example Program:

```
100 PRINT "THIS LINE STARTS AT TAB (0)"
110 PRINT TAB (5);"THIS LINE STARTS AT TAB (5)"
120 END
```

PRINT USING
(Available only with diskette extension)

PRINT USING lets you format your output in many ways:

- Numeric variable digits can be placed exactly where you want them.
- You can insert a decimal point in dollar amounts.
- You can place a dollar sign ($) immediately in front of the first digit of a dollar amount.
- You can print a dollar sign ahead of an amount.
- Amounts can be padded to the left with asterisks (***$45.00) for check protection purposes.
- Numbers can be forced into exponential (E) or double-precision (D) format.
- A plus sign (+) causes output to print as a + for positive and a − for negative numbers.

PRINT USING

The pound sign # holds a position for each digit in a number. Digits can be specified to the right or left of the decimal point with the pound sign. Zeros are inserted to the right of the decimal, if needed, in the case where the amount is in whole dollars. Decimal points are automatically lined up when # is used. The # is convenient in financial programming.
Example Program:

```
10 X=246
20 PRINT USING "###";X
RUN RETURN
 246
```

Note: If a number has more digits than the number of pound signs, then a percent sign will print in front of the number.
Example Program:

```
100 X=99999
110 PRINT USING "###";X
120 END
RUN RETURN
%99999
```

PRINT USING.

Place the period anywhere within the # decimal place holders. The decimal in the amount will align with the decimal in the USING specification.

```
10 X=2.468
20 PRINT USING "##.##";X
RUN RETURN
2.47
```

Note: Since only two digits were specified after the decimal point, the cents position was automatically rounded up.

PRINT USING,

Place a comma in any PRINT USING digit position. The comma symbol causes a comma to print to the left of every third digit in the result.

Note: Extra decimal position holders (#) must be used if more than one comma is expected in a result.

Example Program:

```
 5 DEFDBL X
10 X = 2933604.53
20 PRINT USING "########,##";X
30 END
```

RUN **RETURN**

2,933,604.53

PRINT USING **

Two asterisks in the first two positions fill unused spaces in the result with asterisks. The two asterisks count as two additional digit positions.

Example Program:

```
100 X = 259
120 PRINT USING "**#######.##";X
```

RUN **RETURN**

******259.00

PRINT USING $

A dollar sign at the starting digit position causes a dollar sign to print at the left digit position in the result.

Example Program:

```
100 X = 3.59631
110 PRINT USING "$###.##";X
120 END
```

RUN **RETURN**

$ 3.60

PRINT USING $$

Two dollar signs ($$) in the first two positions give a floating dollar sign in the result. That is, the dollar sign will be located immediately next to the first decimal digit that is displayed.

Example Program:

```
100 X = 3.5961
110 PRINT USING "$$###.##";X
120 END
```

RUN **RETURN**

$3.60

PRINT USING **$

If **$ is used in the first three positions, the result will have asterisks filling unused positions and a dollar sign will float to the position immediately in front of the first displayed digit.

Example Program:

```
100 X = 53.29
110 PRINT USING "**$########.##";X
120 END
```

RUN **RETURN**

********$53.29

PRINT USING ^^^^

Four exponentiation symbols after the pound sign (#) decimal place holder will cause the result to be in exponential (E or D) form.

Example Program:

```
100 X = 500
110 PRINT USING "## ^^^^ ";X
120 END
```

RUN **RETURN**

```
5E + 02
```

PRINT USING +

The plus sign (+) prints a + for positive and a minus (-) for negative in front of a number. The plus sign (+) can be used at the beginning or end of the PRINT USING string.

Example Program:

```
100 A = 999.55
110 PRINT USING " + ####";A
120 END
```

RUN **RETURN**

```
+ 1000
```

PRINT USING -

The minus (-) sign following the PRINT USING string makes a - appear following a negative number. And a trailing space will appear if the number is positive.

Example Program:

```
100 A = -998
110 PRINT USING "----";A
120 END
```

RUN **RETURN**

```
998-
```

PRINT USING !

The exclamation sign (!) pulls the first character out of a string.

Example Program:

```
100 A$ = "B MATHEMATICS 1A"
110 PRINT USING "!";A$
120 END
```

RUN **RETURN**

```
B
```

PRINT USING %bbbb%

The percent signs (%) and blank spaces (b) will pull part of a string out of a longer string. The length of the string you pull out is 2 plus the number of spaces (b's) between the percent signs.

Example Program:

```
100 A$ = "Smith Fred"
120 PRINT USING "%bbb%";A$
130 END
```

RUN **RETURN**

```
Smith
```

PUT

Formats: PUT#iocb, |AT(sector, byte);| arithmetic_expression
Examples: 100 PUT#6, AT(8,2)J,K,L

GET and PUT are opposites. PUT outputs a single byte value from 0-255 to the file specified by #iocb (# is a mandatory character in both of these commands).

The example program below creates a file called "MYFILE" and outputs three numbers to it on your diskette. Use the example program for the GET statement to get the three numbers.

Example Program:

```
10 OPEN #1, "D:MYFILE" OUTPUT
20 PUT #1, 65, 66, 67
30 CLOSE #1
```

RANDOMIZE

Format: RANDOMIZE |seed|
Examples: 10 RANDOMIZE
10 RANDOMIZE 55 !Sets a certain repeatable sequence

RANDOMIZE assures that a different random sequence of numbers occurs each time a program with the RND arithmetic function (see Section 5) is run. RANDOMIZE gives a random seed to the starting point of the RND sequence.

Example Program:

```
100 RANDOMIZE
110 PRINT RND
120 END
```

Each time you run the above program, a unique number prints on the television screen.

Without the RANDOMIZE command the RND arithmetic function repeats the same pseudo-random number each time a program is run. In testing a program it is sometimes ideal to have an RND sequence that you know is the same each time. In this case, use the RND function by itself without RANDOMIZE. Another way to produce a long sequence that is the same each time, is to use RANDOMIZE |seed| (where |seed| is an arbitrary number). But if you wish to see a different set of cards each time you play the game, just use RANDOMIZE by itself somewhere near the start of your program.

Example of RND without RANDOMIZE:

```
100 PRINT RND
110 END
```

Each time you run this program, it prints the same number on the television screen.

READ/DATA

Format: READ variable_name_1,|variable_name_2,||variable_name_n|
Example: 150 READ A,B

READ assigns numbers or strings in the DATA statement to variable names in the READ statement. Commas separate variable names in the READ statement and items in the data statement. Hence, it is all right to leave extra spaces between items because the comma determines the end of items. READ A, B, C looks at the first three DATA items. If READ A, B, C is executed again, the next three numbers of the data statement are assigned to A, B, C, respectively. The pairing of variables and data continues until all the data are read.

Formats: DATA arithmetic_constant,|arithmetic_constant|
DATA string_constant,|string_constant|
Examples: 140 DATA 55,793,666,94.7,55
150 DATA ACCOUNT,AGE,''''''NAME'''''',SOCIAL SECURITY

The arithmetic constants and string constants in the DATA statement are assigned to variable names by the READ statement. Use a comma to separate the entries that you wish to input with READ/DATA. More than one DATA statement can be used. The first DATA item is assigned the first variable name encountered in READ; the second DATA item is assigned the second variable name, and so on. When all the items are read and the program tries to read data when none exists, an "out-of-data" error occurs. The ERR statement can be used to test for the out-of-data condition.

If a comma is included in a string item in a DATA statement, then the whole string item must be enclosed in quotation marks. Otherwise, it could be mistaken as a comma used to separate items. Quotation marks are not required if a string uses numeric values as string data.

Example of READ/DATA:

```
100 FOR J = 1 TO 3
120 READ A$,A
130 PRINT A$,A
140 NEXT J
150 DATA FRED,50,JACK,20,JANE,200
900 PRINT "END OF DATA"
910 END
```

REM or ! or '

Format: REM
Examples:

```
10 REM THIS PROGRAM COMPUTES THE AREA OF A SPHERE
20 LET R = 25 !Sets an initial value
30 GOSUB 225 'GO TO COMPUTATION SUBROUTINE
65 PRINT R: REM PRINTS RADIUS
```

Format: ! and '
Examples: 10 PRINT "EXAMPLE" !TAIL COMMENTS
20 GOTO 10 ! USE ! and '

The exclamation point (!) and the accent(') are used after a statement for comments. REM must start right after the line number or colon, while ! and ' do not require a preceding colon.

REM, !, and ' are used to make remarks and comments about a program. REM does not actually execute. Although REM statements use more memory, it is a valuable aid to reading and documenting a program.

RESTORE

Format: RESTORE |line_number|
Examples: 440 RESTORE 770
550 RESTORE

The RESTORE statement is used if data items are to be used again in a program. That is, RESTORE allows use of the same DATA statement a number of times. Without the RESTORE statement, an out-of-data error results from the attempt to READ data a second time. The data can be restored starting with a particular line number using the optional "line_number." The example program will direct program execution to line 50 when it encounters RESTORE 50.

```
10 REM READ — DATA — RESTORE DEMO
20 DIM A(15)
30 FOR I = 1 TO 10:READ A(I):PRINT A(I)NEXT I
40 DATA 1,2,3,4,5
50 DATA 6,7,8,9,10
60 DATA 11,12,13,14,15
70 RESTORE 50
80 FOR N = 1 TO 10: READ A(N): PRINT A(N);:NEXT N
```

RESUME

Formats: RESUME |line_number|
RESUME |NEXT|
RESUME
Examples: 300 RESUME 55
440 RESUME NEXT
450 RESUME

RESUME is the last statement of the ON ERROR line_number error-handling routine. RESUME transfers control to the specified line number.

RESUME NEXT transfers execution to the statement following the occurrence of the error.

RESUME transfers execution back to the originating (error-causing) line number if you do not follow RESUME with NEXT or line_number.

RETURN

Format: RETURN
Example: 550 RETURN

RETURN returns the program to the line number after the GOSUB statement that transferred execution to this group of statements.
Example Program:

```
10 X = 1
20 GOSUB 80
30 PRINT X
40 X = 3
50 GOSUB 80
60 PRINT X
70 STOP
80 X = X * 2
90 RETURN
```

STACK

Format: STACK
Examples: 120 PRINT STACK !Prints no. of stack entries available
310 IF STACK = 0 THEN PRINT "STACK FULL"

The STACK function gives the number of entries available on the time stack. The time stack can hold 20 jiffie entries. The STACK is used to hold the SOUND and AFTER jiffie times.

STOP

Format: STOP
Example: 190 STOP

STOP is used to halt execution of a program at a place that is not the highest line number in the program. The STOP command prints the line number where execution of the program is broken. STOP is a useful debugging aid because you can use PRINT in the direct mode to show the value of variables at the point where execution halts.

VARPTR

Formats: VARPTR(variable_name)
VARPTR(PLM1)
VARPTR(PLM2)
VARPTR(CHR1)
VARPTR(CHR2)
VARPTR(RESERVE)
Examples: 110 A = VARPTR(A$)
100 PRINT VARPTR(A$) + 1
120 J = VARPTR(TOTAL)
120 T = VARPTR(CHR2)
155 POKE VARPTR(RESERVE),&FE

If the argument to this function is a variable name, the function returns the address of the variable's symbol table entry. When the variable is arithmetic, VARPTR returns the variable's 2-byte starting address (most significant byte, least significant byte) in memory. When the variable is a string, VARPTR returns the number of bytes in the string. Then the starting location of the string is given in VARPTR(A$) + 1 (least significant byte) and VARPTR(A$) + 2 (most significant byte). Notice that only in the case of strings is the address given in the 6502 notation of low-memory byte before the high-memory byte. Except in the case of strings the whole address in high-byte/low-byte format is returned with VARPTR. The following keywords can be used with VARPTR:

VARPTR(PLMn) Returns the address (MSB, LSB) of the first byte allocated for PLMn.

VARPTR(CHRn) Returns the address (MSB, LSB) of the first byte allocated for CHRn.

VARPTR(RESERVE) Returns the address (MSB, LSB) of the first byte allocated for assembly language programs.

Use OPTION PLM1, OPTION PLM2, OPTION CHR1, OPTION CHR2, and OPTION RESERVE n to allocate space. Once OPTION has been used to set aside space, VARPTR can be used to point to the starting byte of that space.

WAIT...AND

Format: WAIT address, AND_mask_byte, compare_to_byte
Example: 330 || WAIT || &D40B,&FF,110 !WAIT FOR VBLANK

WAIT stops the program until certain conditions are met. Execution waits until the compare_to_byte, when ANDed with the AND_mask_byte, equals the location address of the byte contained in memory.

WAIT is ideal if you need to halt execution until VBLANK occurs (refer to *De Re Atari* for detailed explanation of VBLANK). VBLANK occurs every 1/60 of a second. It consists of a number of lines below the visible scan area.You can make sure that your screen is interrupted halfway through its scan lines (causing the screen to blip) if you WAIT until a VBLANK occurs. This technique is used to animate characters as shown in Appendix C, "Alternate Character Sets." See Appendix A for an example of the WAIT statement used to control the timing of vertical fine scrolling.

PROGRAM FUNCTIONS 5

NUMERIC FUNCTIONS

ABS
Format: ABS (expression)
Example: ABS (-7)

ABS returns the absolute value of a number. The sign of a number is always positive after this function is executed. If the number -7 (negative 7) is evaluated with ABS, the result is 7 (positive 7).

ATN
Format: ATN (arithmetic_expression)
Example: ? ATN (.66) Prints arctangent of .66 as .583373 radian.

ATN returns the arctangent of the arithmetic expression.

COS
Format: COS (arithmetic_expression)
Example: ? COS (.95) Prints cosine of .95 as .581683 radian.

COS returns the trigonometric cosine of the arithmetic expression.

EXP
Format: EXP (arithmetic_expression)
Example: ? EXP (3) Prints 20.0855.

EXP returns the Euler's number (e) raised to the power of the arithmetic expression within the parentheses.

INT
Format: INT (arithmetic_expression)
Examples: ? INT (5.3) Prints 5 on your television screen.
? INT (-7.6) Prints -8 on your television screen.

INT returns an integer for the arithmetic expression. INT always rounds to the next lower integer.

LOG
Format: LOG (arithmetic_expression)
Example: ? LOG (5) Prints the natural logarithm 1.60944.

LOG returns the natural logarithm (LOG_e) of a nonnegative arithmetic expression in the parentheses. LOG (0) will give a FUNCTION CALL ERROR. LOG (1) is 2.32396E-8.

RND
Formats: RND
RND (0) Same as RND above.
RND (integer)
Examples: ? RND Prints 6 random digits after decimal point.
RND (37) Prints a number between and including 1 through 37.

RND returns random numbers. RND and RND (0) return random numbers between but not including 0 and 1. RND (integer) returns a positive integer between and including 1 and the (integer).

SGN
Format: SGN (arithmetic_expression)
Example: ? SGN (-34) Prints -1 on your television screen.

SGN returns the sign of the arithmetic expression enclosed in parentheses. The sign is + 1 if the number within the parentheses is positive, 0 if the number is 0, or -1 if the number is negative.

SIN
Format: SIN (arithmetic_expression)
Example: ? SIN (1) Prints the sine of 1 as .841471 radian.

SIN returns the trigonometric sine of the arithmetic expression.

SQR
Format: SQR (arithmetic_expression)
Example: ? SQR (25) Prints 5 on your television screen.

SQR returns the square root of a positive arithmetic expression enclosed in parentheses. If the arithmetic expression evaluated by SQR has a negative (-) sign, you will get a FUNCTION CALL ERROR.

TAN
Format: TAN (arithmetic_expression)
Example: ? TAN (.22) Prints the tangent of .22 as .223619 radian.

TAN returns the trigonometric tangent of the arithmetic expression.

STRING FUNCTIONS

+ (CONCATENATION OPERATOR)
Format: string + string
Example: 110 C$ = A$ + B$

Use the + symbol to join two strings.
Example Program:

```
110 A$ = "never"
120 B$ = "more"
130 Z$ = A$ + B$
140 PRINT Z$
```

RUN **RETURN**

nevermore

ASC
Format: ASC (string_expression_$)
Example: ? ASC("Smith")!prints 83 (ATASCII decimal code for letter S)

ASC gives the ATASCII code in decimal for the first character of the string expression. See Appendix K for ATASCII character set.

CHR$
Format: CHR$ (ATASCII_code_number)
Examples: 110 PRINT CHR$ (123) !prints ATASCII club symbol
100 PRINT CHR$(65) !PRINTS ATASCII CHARACTER A

CHR$ converts an ATASCII value into a one-character string. CHR$ is the opposite of the ASC function. The "ATASCII_code_number" can be any number from 0 to 255. Appendix K gives a table of both the character set and the ATASCII code numbers.

INKEY$
Format: INKEY$
Example: 110 A$ = INKEY$

INKEY$ returns the last key pressed. If no keys are currently being pressed on the keyboard, a null string is returned. In the example program, statement 110 tests for a null string by representing it as two double quotation marks with no space between them. ATARI Microsoft BASIC II does not recognize the space bar since leading and trailing blanks are trimmed for INKEY$.
Example Program:

```
100 A$ = INKEY$
110 IF A$ < > "" THEN PRINT "You typed a "; A$
120 GOTO 100
```

INSTR
Format: INSTR (m,A$,B$)
Example: 110 HOLD = INSTR(5,C$,B$)

INSTR searches for a small string B$ within a larger string A$. The search begins at the m-th character. If m is missing, the starting position is assumed to be the first character. The function returns a number representing the character position of the first B$ found within A$, or a 0 if B$ is not found.

LEFT$
Format: LEFT$(string_expression_$,n)
Example:

```
100 A$ = "TOTALAMOUNT"
110 PRINT LEFT$(A$,5)
```

LEFT$ returns the leftmost n characters of the string expression.

LEN
Format: LEN (string_expression_$)
Example:

```
100 A$ = "COUNT THE"
120 ? LEN (A$ + " CHARACTERS")!prints total number of
130 !characters as 20
```

LEN returns the total number of characters in the specified string expression. LEN stands for length. Spaces, numbers, and special symbols are counted.

MID$
Format: MID$(string_expression_$,m,n)
Example:

```
100 A$ = "GETTHEMIDDLE"
110 PRINT MID(A$,4,3)
```

MID$ extracts a portion of the string. The string is identified by the first parameter of the function. The second parameter tells the starting character. The third parameter tells how many characters you want.
Example Program:

```
110 A$ = "AMOUNT OF INTEREST PAID"
120 B$ = MID$(A$,11,8)!THIS CAUSES "INTEREST" TO BE PRINTED
130 PRINT B$
```

RIGHT$
Format: RIGHT$(string_expression_$,n)
Example:

```
100 A$ = "THERIGHT"
110 PRINT RIGHT$(A$,5)
```

RIGHT$ returns the rightmost n characters of the string expression.

SCRN$
Format: SCRN$(X,Y)
Example: 10 ? SCRN$(5,5)

The character at the X-coordinate and Y-coordinate is returned as the value of the function in character-graphics modes. In other graphics modes, SCRN$ returns the color register number being used by the pixel at location X,Y.
Example of SCRN$(X,Y) in a character-graphics mode:

```
10 GRAPHICS 1
20 COLOR 1
30 PRINT#6, AT(5,5);"A"
40 A$ = SCRN$(5,5)
50 PRINT "Character is:";A$
60 END
```

Example of SCRN$(X,Y) in graphics mode:

```
100 GRAPHICS 7
110 COLOR3
120 PLOT 5,5
130 A$ = SCRN$ (5,5)
140 PRINT "COLOR REGISTER IS:";ASC(A$)
150 END
```

Note: Use the LEN function to be sure that the returned string is not null (color register zero).

STR$
Format: STR$ (arithmetic_expression)
Example: 100 A = 999.02
110 PRINT STR$(A)

STR$ turns an arithmetic expression into a string. String operations can then be carried out with the resultant strings. Note that when the following two strings are brought together with the concatenation symbol, there is a space between them that represents the sign of the positive number.
Example Program:

```
100 NUM1 = -22.344
120 NUM2 = 43.2
130 PRINT STR$ (NUM1) + STR$ (NUM2)
140 END
```

RUN RETURN

```
 -22.344 43.2
```

STRING$ (n,A$) (Available only with the extension diskette)
Format: STRING$ (n,A$)
Example: 100 A$ = STRING$(20,"*")

STRING$(n,A$) returns a string composed of n repetitions of A$.

STRING$ (n,m) (Available only with the extension diskette)
Format: STRING$ (n,m)
Example: 110 PRINT STRING$(20,123)!prints 20 clubs

STRING$(n,m) returns a string composed of n repetitions of CHR$(m).

TIME$
Format: TIME$ = "hours:minutes:seconds" elapsed clock time
Example: 100 PRINT TIME$

TIME$ sets the time to the "hours:minutes:seconds" format and keeps it current (± 90sec per 24 hours).

Examples: 110 TIME$ = "22:55:05"
120 TIME$ = "05:30:09"

Note: Use leading zeros to make hours, minutes, and seconds into 2-digit numbers.

After TIME$ is set, you can use it in a program. TIME$ is continually updated to the current time. For example:

```
100 GRAPHICS 2
110 TIME$ = "11:59:05"
120 PRINT#6, AT(3,3)"DIGITAL CLOCK"
130 PRINT#6, AT(4,4)TIME$
140 GOTO 120
```

VAL
Format: VAL (numeric_string_expression_$)
Example:
```
100 B$ = "309"
120 ? VAL (B$) !prints the number 309
130 END
```

VAL converts strings to numeric values. VAL returns the numeric value of the numeric constant associated with the "numeric_string_expression." Leading and trailing spaces are ignored. Digits up to the first nonnumeric character are converted. For example, PRINT VAL("123ABC") prints 123.If the first character of the string expression is nonnumeric, then the value returned is 0 (zero).

SPECIAL-PURPOSE FUNCTIONS

EOF
Format: EOF(n)
Example: 120 IF EOF(4) = 0 THEN GOTO 60

A value of true (1) or false (0) is returned indicating the detection of an end-of-file condition on the last read of IOCB n.

ERL
Format: ERL
Example: 100 PRINT ERL

ERL returns the line number of the last encountered error.

ERR
Format: ERR
Example:
```
120 PRINT ERR
150 IF ERR = 135 THEN GOTO 350
```

ERR returns the error number of the last encountered error.

FRE (0)
Format: FRE (0)
Example: PRINT FRE(0)

This function gives you the number of memory bytes that are free and available for your use. Its primary use is in direct mode with a dummy variable (0) to tell you how much memory space remains. Of course FRE can also be used within a BASIC program in deferred mode.

Using FRE (0) releases string memory locations that are not in use. This use of FRE (0) to pick up the string clutter is referred to as "garbage collection."

PEEK
Format: PEEK (address)
Examples: 110 PRINT PEEK(1034)
135 PRINT PEEK(ADDR)

PEEK (&FFF) looks at the address enclosed in the parentheses, in this case FFF hexadecimal. PEEK is used to examine the content of a particular memory location. You can examine ROM as well as RAM. All memory can be looked at with the PEEK instruction. PEEK always returns a decimal value.
Examples:

PRINT PEEK(888)	Prints the contents of memory location 888 (decimal).
PRINT PEEK (&FFFF)	Prints the contents of memory location FFFF hex (hexadecimal).

POKE
Format: POKE address,byte
Examples: POKE 2598,255
110 POKE ADDR3,&FF
120 POKE PLACE,J

POKE writes data into a memory location. The address and byte can be expressed as decimal or hexadecimal numbers. The address and byte can also be expressions. Thus, if X*Y-2 evaluates to a valid memory location or byte, it can be used.
Examples:

POKE &FFF,43	Writes the number 43 into memory location FFF (hexadecimal).
X = 22	
Y = &8F	
POKE X,Y	Writes the hexadecimal number 8F into memory location 22 (decimal).

Note that decimal and hexadecimal are just two ways of assigning a number to the 8-bit byte. The highest number you are allowed to POKE, a byte, is FF in hexadecimal and 255 in decimal.

STATUS
Formats: STATUS (iocb_number)
STATUS ("device:program_name")
Examples: 100 A = STATUS (6)
120 A = STATUS ("D:MICROBE.BAS")

STATUS returns the value of the fourth byte of the iocb block (status byte). The most significant bit is a 1 for error conditions; a zero indicates nonerror conditions. The remaining bits represent an error number.

TABLE 5-1 LIST OF STATUS CODES

Hex	Dec	Meaning
01	001	Operation complete (no errors)
03	003	End of file (EOF)
80	128	**BREAK** key abort
81	129	IOCB already in use (OPEN)
82	130	Nonexistent device
83	131	Opened for write only
84	132	Invalid command
85	133	Device or file not open
86	134	Invalid IOCB number (Y register only)
87	135	Opened for read only
88	136	End of file (EOF) encountered
89	137	Truncated record
8A	138	Device timeout (doesn't respond)
8B	139	Device NAK
8C	140	Serial bus input framing error
8D	141	Cursor out of range
8E	142	Serial bus data frame overrun error
8F	143	Serial bus data frame checksum error
90	144	Device-done error
91	145	Bad screen mode
92	146	Function not supported by handler
93	147	Insufficient memory for screen mode
A0	160	Disk drive number error
A1	161	Too many open disk files
A2	162	Disk full
A3	163	Fatal disk I/O error
A4	164	Internal file number mismatch
A5	165	Filename error
A6	166	Point data length error
A7	167	File locked
A8	168	Command invalid for disk
A9	169	Directory full (64 files)
AA	170	File not found
AB	171	Point invalid

TIME
Format: TIME
Example: 200 PRINT TIME

TIME gives the content of the system's real-time clock (RTCLOK) locations. The decimal locations 18, 19, and 20 (RTCLOK) keep the system time in jiffies (1/60 of a second). Six decimal digits are returned by TIME. The difference between TIME$ and TIME is that TIME$ gives the time in standard hours, minutes, and seconds, while TIME gives the time as a jiffie count.

USR

Format: USR (address,n1)
Example: 550 A = USR(898,0)

The USR function allows you to transfer your program execution to a machine language routine. This is an advanced programming function that enables you to take full advantage of all the computer's special features. The USR function expects two parameters: the first is a memory address; the second is an optional value, n1. The value of n1 is usually the address of a data table, but may also be a value passed to the routine for specific action.

After the USR function is executed, the parameters are stored in &E3 and &E4 (data). The example program is a color switch performed at machine language speed.

Example Program:

```
10 !ROUTINE TO TEST USR FUNCTION CALL TO AN
20 !ASSEMBLY ROUTINE STORED IN MEMORY
30 !ASSEMBLY ROUTINE IS:
40 !LDA #35
50 !STA 710
60 !RTS
70 !
80 !
90 !
100 A = 0:I = 0:COL = 0:C = 0
110 OPTION RESERVE 10
120 ADDR = VARPTR(RESERVE) !STARTING ADDRESS
130 FOR I = 0 TO 5
140 READ A
150 POKE ADDR + I,A
160 NEXT I
170 DATA &A9,&23,&8D,&C6,&02,&60
180 A = USR(ADDR,VARPTR(I))
190 STOP
```

FUN FEATURES 6

GRAPHICS OVERVIEW

The GRAPHICS command selects one of up to 12 graphics modes. Graphics modes are numbered 0 through 11 with GTIA (0–8 with CTIA). (Refer to *De Re Atari* for a detailed description of GTIA and CTIA.) The arithmetic expression following GRAPHICS must evaluate to a positive integer. Graphics mode 0 is a full-screen text mode. ATARI Microsoft BASIC II defaults to GRAPHICS 0.

GRAPHICS 1 through 8 are split-screen modes. In the split-screen modes a 4-line text window is at the bottom of the television screen.

GRAPHICS 0, GRAPHICS 1, and GRAPHICS 2 display characters in different sizes. GRAPHICS 0 displays regular-size characters. GRAPHICS 1 displays double-width characters. GRAPHICS 2 displays double-width and double-height characters. Graphics characters (CONTROL key characters) cannot be displayed in GRAPHICS 1 or 2 unless you change the character base (POKE 756, 226).

GRAPHICS 3 through GRAPHICS 11 are modes for plotting points directly on your television screen. The graphics mode dictates the size of the plot points and the number of playfield colors you can use. The maximum number of playfield colors in the point-plotting modes is four. But it is possible to get four more colors on your television screen by using players and missiles. For information on player-missile graphics, see Section 7.

GRAPHICS 9 through 11 are only available if your system has a GTIA chip. GRAPHICS 9 allows you to have one playfield color with 16 luminances. GRAPHICS 10 can have nine playfield colors with eight luminances. GRAPHICS 11 can have 16 colors with one luminance.

GRAPHICS

Format: GRAPHICS arithmetic_expression
Examples: GRAPHICS 2

```
100 GRAPHICS 5 + 16
170 GRAPHICS 1 + 32 + 16
120 GRAPHICS 8
150 GRAPHICS 0
140 GRAPHICS 18
```

Use GRAPHICS to select one of the graphics modes (0 through 11). Table 6-1 summarizes the 12 modes and characteristics of each. GRAPHICS 0 is a full-screen text display. Characters can be printed in GRAPHICS 0 by using the PRINT statement. GRAPHICS 1 through GRAPHICS 8 are split-screen modes. These split-screen modes actually include four lines of GRAPHICS 0 at the bottom of the television screen. This text window uses the PRINT statement. To print in the large graphics window in GRAPHICS 1 and GRAPHICS 2, use *PRINT#6.* The following program prints in the graphics window in GRAPHICS 1 or GRAPHICS 2:

```
100 GRAPHICS 1
110 PRINT#6, AT(3,3);"GRAPHICS WINDOW"
120 PRINT "TEXT WINDOW"
```

Adding + 16 to GRAPHICS 1 through GRAPHICS 11 will override the text window and make a full screen graphics mode. If you run the following program without line 140, the screen returns to graphics mode 0. Press the **BREAK** key to escape from the loop at line 140.

```
110 GRAPHICS 2 + 16
120 PRINT#6, AT(3,3);"WHOLE SCREEN IS"
130 PRINT#6, AT(4,4);"GRAPHICS 2"
140 GOTO 140
```

BREAK

Normally the screen is cleared of all previous graphics characters when a GRAPHICS n statement is encountered. Adding + 32 prevents the graphics command from clearing the screen.

Graphics modes 3 through 11 are point-plotting modes. To draw point graphics you need to use the COLOR n and PLOT statements. Use of the SETCOLOR statement allows you to change the default colors to any one of 128 different color/luminance combinations. Point-plotting modes are explored in the example at the end of this section.

To return to GRAPHICS 0 in direct mode, type **GRAPHICS 0** and press the **RETURN** key.

TABLE 6-1 GRAPHICS MODES AND SCREEN FORMATS

	Graphics Mode	Mode Type	Columns	Rows-- Split Screen	Rows-- Full Screen	Number of Colors	RAM Required (Bytes)
	0	TEXT	40	-	24	1-1/2	992
	1	TEXT	20	20	24	5	674
	2	TEXT	20	10	12	5	424
	3	GRAPHICS	40	20	24	4	434
CTIA	4	GRAPHICS	80	40	48	2	694
	5	GRAPHICS	80	40	48	4	1174
	6	GRAPHICS	160	80	96	2	2174
	7	GRAPHICS	160	80	96	4	4198
	8	GRAPHICS	320	160	192	1-1/2	8112
	9	GRAPHICS	80	-	192	1	8112
GTIA	10	GRAPHICS	80	-	192	9	8112
	11	GRAPHICS	80	-	192	16	8112

GRAPHICS 3 through 11 plot individual points on your television screen. The number following GRAPHICS determines the size of the points you plot. GRAPHICS 3 has the largest plot points. The example program can be used to demonstrate the size of the plot points in modes 3-8.

Example Program:

```
10 INPUT "WHAT GR. MODE (3-8)?";G
20 GRAPHICS G + 16
30 COLOR 1
40 PLOT 5,5
45 FOR H = 1 TO 1900:NEXT
50 GOTO 10
```

If you insert a new statement (statement 15), 15 SETCOLOR 4,4,8, you will get large pink dots instead of the default orange. This change to the original plotting program gives you pink plot points because SETCOLOR 4,x,x aligns with COLOR 1 in GRAPHICS 3.

COLOR

Format: COLOR n
Example: 100 COLOR 4

COLOR is used with PLOT to draw up to four colors on the television screen. You must have a COLOR statement in GRAPHICS 3 through 11 in order to plot a color. When you use the COLOR statement without a prior SETCOLOR command you get the default colors (what is currently in the color registers).

The color registers are initialized according to Table 6-2. For example, the default colors for GRAPHICS 3 are: orange for color register 4, light green for color register 5, dark blue for color register 6, and black for color register 8.

Note: You must always have a COLOR statement to plot a playfield point, but SETCOLOR is only necessary to make a color other than a default color.

TABLE 6-2 DEFAULT COLORS, MODE, SETCOLOR, AND COLOR

Default Colors	Mode	Color Register	Color n	Description and Comments
	GRAPHICS 0	4	Register	
Light blue		5	holds	Character luminance
Dark blue		6	character	(same as background)
		7		Character
Black	**Text Mode**	8	Border	
Orange		4		Character
Light green	GRAPHICS 1,2	5		Character
Dark blue		6		Character
Red		7		Character
Black	**Text Modes**	8		Background, border
Orange		4	1	Graphics point
Light green	GRAPHICS 3,5,7	5	2	Graphics point
Dark blue		6	3	Graphics point
		7	-	———
Black	**4-color modes**	8	0	Background, border
Orange	GRAPHICS	4	1	Graphics point
	4 and 6	5	-	———
		6	-	———
		7	-	———
Black	**2-color modes**	8	0	Background, border
	GRAPHICS 8	4	-	———
Light blue		5	1	———
Dark blue		6	0	———
		7	-	———
Black	**1 color/2 lums.**	8	-	Border
Black	GRAPHICS 9	8	0–15	Graphics point. Color value determines luminance.
Black	GRAPHICS 10	0	0	Graphics point
Black		1	1	Graphics point
Black		2	2	Graphics point
Black		3	3	Graphics point
Orange		4	4	Graphics point
Light Green		5	5	Graphics point
Dark Blue		6	6	Graphics point
Red		7	7	Graphics point
Black		8	8	Background
Gray	GRAPHICS 11	8	0–15	Graphics point-color value determines hue

Note: Player-missile graphics color is SETCOLOR register, color, luminance, where register = 0, 1, 2, 3 and determines color of player-missile 0, 1, 2, 3, respectively. Player-missile graphics will work in all graphics modes.

SETCOLOR

Format: SETCOLOR register,hue,luminance
Example: 330 SETCOLOR 5,4,10

The SETCOLOR statement associates a color and luminance with a color register.

The color registers 0, 1, 2, 3 are for player-missiles 0, 1, 2, 3 respectively. Color registers 4, 5, 6, 7 are for playfield colors assignments. Register 8 is always the background register.

The color hue number must be any number from 0 to 15. (See Table 6-3.)

The color luminance must be an even number between 0 and 14; the higher the number, the brighter the display; 14 is almost pure white.

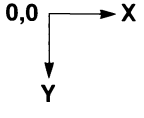
TABLE 6-3 THE ATARI HUE (SETCOLOR COMMAND) NUMBERS AND COLORS

Colors	SETCOLOR Hue Number (Decimal)	SETCOLOR Hue Number (Hexadecimal)
Gray	0	0
Light orange (gold)	1	1
Orange	2	2
Red-orange	3	3
Pink	4	4
Purple	5	5
Purple-blue	6	6
Azure blue	7	7
Sky blue	8	8
Light blue	9	9
Turquoise	10	A
Green-blue	11	B
Green	12	C
Yellow-green	13	D
Orange-green	14	E
Light orange	15	F

PLOT/PLOT. . .TO

Formats: PLOT X,Y
PLOT X,Y TO X,Y
Examples: 100 PLOT 12,9
112 PLOT 6,9 TO 3,3

Use PLOT to draw single-point plots, lines, and outline objects on the television screen. PLOT uses an X-Y coordinate system for specifying individual plot points. The X coordinate stands for the horizontal column. The Y coordinate stands for the vertical row. (See Table 6-1.) Give a number from 0 to whatever the maximum is for the current mode, X first, then Y.



You can "chain" the PLOT instruction. That is, one plot point can be made to draw to the next plot point. The result of chaining two PLOT points is a straight line. It is also easy to outline an object using chained plots. To chain plots, use the word TO between the PLOT X,Y statements.

```
Example Program: 90 COLOR 1              !Use a COLOR instruction before PLOT
                 100 PLOT 5,5 TO 5,15    !Draws a straight line
```

Here is an example program that shows PLOT, COLOR, and SETCOLOR at work:

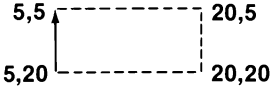
```
100 GRAPHICS 3+16 !THE 16 GETS RID OF TEXT WINDOW
110 SETCOLOR 5,4,8 !PINK
120 SETCOLOR 6,0,4 !GRAY
130 SETCOLOR 8,8,6 !BLUE
140 COLOR 1 !COLOR 1 GOES WITH DEFAULT ORANGE
150 PLOT 5,5 TO 10,5 TO 10,10 TO 5,10 TO 5,5 !IN ORANGE
160 COLOR 2 !PINK
170 PLOT 7,7 TO 12,12 TO 2,12 TO 7,7
180 COLOR 3 !GRAY
190 PLOT 2,7 TO 12,7
200 GOTO 200
```

FILL

Format: FILL X,Y TO X,Y
Example: 550 FILL 10,10 TO 5,5

FILL fills an area with the color specified by the COLOR and any SETCOLOR statements. The FILL process sweeps across the television screen from left to right. FILL stops painting and starts its next sweep when it bumps into a PLOT line or point. The line on the left-hand side of a filled object is specified by the FILL statement itself.

An example shows how FILL operates. First the outline of three sides of a box are specified. PLOT 5,5 TO 20,5 TO 20,20 TO 5,20 makes the top, right side, and bottom of the box. Make the left side and FILL with the statement FILL 5,5 TO 5,20. Example:




```
10 GRAPHICS 5
20 SETCOLOR 4,12,8 !Register 4, green, medium brightness
30 COLOR 1 !COLOR 1 is paired with SETCOLOR 4 in GRAPHICS 5
40 PLOT 5,5 TO 20,5 TO 20,20 TO 5,20
50 FILL 5,5 TO 5,20
60 END
```

Line 40 in the above example makes three sides of a box. Then the FILL statement, line 50, draws the left side and fills the box. The FILL process scans from the FILL line to the right until it reaches the PLOT lines.

CLS

Format: CLS |background_register_option|
Examples: CLS

```
110 CLS
100 GRAPHICS 3: CLS &C5
330 CLS 25
```

CLS clears screen text areas and sets the background color register to the indicated value, if present. In GRAPHICS 0 and GRAPHICS 8 the optional number after CLS determines the border color and luminance. In GRAPHICS 1, 2, 3, 4, 5, 6, 7 the optional number following CLS determines the background color and luminance.

TABLE 6-4 CHARACTERS IN GRAPHICS MODES 1 AND 2

POKE 756,224	POKE 756,226	SETCOLOR 4	SETCOLOR 5	SETCOLOR 6	SETCOLOR 7
		32	0	160	128
!		33	1	161	129
"		34	2	162	130
#		35	3	163	131
$		36	4	164	132
%		37	5	165	133
&		38	6	166	134
'		39	7	167	135
(		40	8	168	136
)		41	9	169	137
*		42	10	170	138
+		43	11	171	139
,		44	12	172	140
-		45	13	173	141
.		46	14	174	142
/		47	15	175	143
0		48	16	176	144
1		49	17	177	145
2		50	18	178	146
3		51	19	179	147
4		52	20	180	148
5		53	21	181	149
6		54	22	182	150
7		55	23	183	151
8		56	24	184	152
9		57	25	185	153
:		58	26	186	154
;		59	27	187	155

(continued)

TABLE 6-4 CHARACTERS IN GRAPHICS MODES 1 AND 2 *(continued)*

POKE 756,224	POKE 756,226	SETCOLOR 4	SETCOLOR 5	SETCOLOR 6	SETCOLOR 7
<	↑	60	28	188	156
=	↓	61	29	189	167
>	←	62	30	190	168
?	→	63	31	191	169
@	♦	64	96	192	224
A	a	65	97	193	225
B	b	66	98	194	226
C	c	67	99	195	227
D	d	68	100	196	228
E	e	69	101	197	229
F	f	70	102	198	230
G	g	71	103	199	231
H	h	72	104	200	232
I	i	73	105	201	233
J	j	74	106	202	234
K	k	75	107	203	235
L	l	76	108	204	236
M	m	77	109	205	237
N	n	78	110	206	238
O	o	79	111	207	239
P	p	80	112	208	240
Q	q	81	113	209	241
R	r	82	114	210	242
S	s	83	115	211	243
T	t	84	116	212	244
U	u	85	117	213	245
V	v	86	118	214	246
W	w	87	119	215	247

(continued)

TABLE 6-4. CHARACTERS IN GRAPHICS MODES 1 and 2 *(continued)*

POKE 756,224	POKE 756,226	SETCOLOR 4	SETCOLOR 5	SETCOLOR 6	SETCOLOR 7
x	x	88	120	216	248
y	y	89	121	217	249
z	z	90	122	218	250
[	♣	91	123	219	251
\	▌	92	124	220	252
]	↖	93	125	221	253
^	◀	94	126	222	254
-	▶	95	127	223	255

Example Programs:
The following programs work in GRAPHICS 1 or GRAPHICS 2. The programs show the alternate basic character set and special character set (POKE 756,226). To restart these two programs, press the **BREAK** key and type **RUN** followed by **RETURN**.

```
2 REM KEYBOARD TYPEWRITER
10 GRAPHICS 2
20 SETCOLOR 4,0,0!to avoid screen full of hearts in lowercase
30 PRINT "TYPE Green/Blue/Red (G/B/R)"
40 INPUT "AND PRESS RETURN? "; C$
50 IF C$ = "G" THEN K = 32
60 IF C$ = "B" THEN K = 128
70 IF C$ = "R" THEN K = 160
80 PRINT "TYPE UPPER/LOWER (U/L)"
90 INPUT "AND PRESS RETURN ? "; B$
100 IF B$ = "U" THEN 120
110 POKE 756,226
120 PRINT "NOW TYPE — ALPHA + CTRL KEYS"
130 A$ = INKEY$
140 IF A$ = "" THEN 130
150 A = ASC(A$) + K!32 is green, 128 is blue, 160 is red
160 PRINT A
170 PRINT #6, CHR$(A);
180 GOTO 130
```

```
100 REM TWINKLE
110 GRAPHICS 16 + 2
120 X = RND(36)
130 ON ERROR GOTO 150
140 PRINT #6, TAB(X);"*"
146 GOTO 120
150 GRAPHICS 32 + 16 + 2
160 RESUME
```

The following short program demonstrates and confirms Table 6-4. This program prints the ATASCII code for a character in the text window and the character itself in the graphics window. Every time you press the **RETURN** key, a new character appears. The reason SETCOLOR 4,0,0 is the same as SETCOLOR 8,0,0 is to avoid a screen filled with hearts. Another way to accomplish this is to lower the character set into RAM (using MOVE) and redefine the heart character as 8 by 8 zeros. See Appendix C, "Alternate Character Sets," for an example of lowering and redefining the character set. The special character set is shown in the program as it is now written. To see the standard character set, just delete line 20. The GRAPHICS 2 instruction automatically pokes 756,224.

```
10 GRAPHICS 2
20 POKE 756,226
30 SETCOLOR 8,0,0
40 SETCOLOR 4,0,0!AVOID SCREEN HEARTS
50 SETCOLOR 5,4,6!PINK
60 SETCOLOR 6,12,2!GREEN + TEXT WINDOW
70 SETCOLOR 7,9,6!LIGHT BLUE
80 A$ = INKEY$
90 IF A$ = "" THEN 80
100 ON ERROR GOTO 150
110 PRINT #6, AT(6,6);CHR$(X)
120 PRINT X
130 X = X + 1
140 GOTO 80
150 RUN !REPEATS WHEN 256 REACHED
```

THE SOUND COMMAND

Format: SOUND voice, frequency, distortion, volume, duration
Examples: 120 SOUND 2,204,10,12,244
100 SOUND 0,122,8,10

The voice can be a number 0 through 3, that is, you may use up to four voices with four SOUND commands.

The frequency is any number between 0 and 255 (see Table 6-5).

The distortion is any number between 0 and 14. The default is a pure tone. A 10 is used to create a "pure" tone. A 12 gives a buzzer sound.

The volume is a number between 0 and 15. Use a 1 to create a sound that is barely audible. Use a 15 to make a loud sound. A value of 8 is considered normal. If more than one SOUND statement is being used, the total volume should not exceed 32. This will create an unpleasant "clipped" tone.

The duration is given in 1/60 of a second. The duration indicates how long a tone or noise lasts. If you do not specify a number for the duration parameter, the tone continues until the program reaches an END statement, another RUN statement, or until you type a second SOUND statement using the same voice number followed by 0,0,0. If an INPUT statement follows a SOUND statement, the sound continues until the INPUT statement is executed. You can also stop the tone by pressing the **BREAK** key.

Example: SOUND 2,204,10,12
SOUND 2,0,0,0

TABLE 6-5 FREQUENCY CHART OF PITCH VALUES

Notes	Hex	Decimal
HIGH NOTES	C	1D 29
	B	1F 31
	A# or B ♭	21 33
	A	23 35
	G# or A ♭	25 37
	G	28 40
	F# or G ♭	2A 42
	F	2D 45
	E	2F 47
	D# or E	32 50
	D	35 53
	C# or D ♭	39 57
	C	3C 60
	B	40 64
	A# or B	44 68
	A	4B 72
	G# or A ♭	4C 76
	G	51 81
	F# or G ♭	55 85
	F	5B 91
	E	60 96
	D# or E ♭	66 102
	D	6C 108
	C# or D ♭	72 114
MIDDLE C	C	79 121
	B	80 128
	A# or B ♭	88 136
	A	90 144
	G# or A ♭	99 153
	G	A2 162
	F# or G ♭	AD 173
	F	B6 182
LOW NOTES	E	C1 193
	D# or E ♭	CC 204
	D	D9 217
	C# or D ♭	E6 230
	C	F3 243

Example Program:

NIGHT LAUNCH

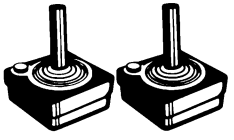
```
10 GRAPHICS 2+16
20 SETCOLOR 4,8,4
30 PRINT#6, AT(3,3);
40 FOR DELAY = 1 TO 1000:NEXT
50 GRAPHICS 2 + 16
60 PRINT#6, AT(3,3);"AT THE CAPE"
70 FOR DELAY=1 TO 1000:NEXT
80 GRAPHICS 0
90 POKE 752,1
100 SETCOLOR 6,0,0
110 FOR T=1 TO 24:PRINT "":NEXT
120 PRINT TAB(11);CHR$(8);CHR$(10)
130 PRINT TAB(11);CHR$(22);CHR$(2)
140 PRINT TAB(11);CHR$(22);CHR$(2)
150 PRINT TAB(11);CHR$(13);CHR$(13)
160 PRINT TAB(11);CHR$(6);CHR$(7)
170 FOR VOL=15 TO 0 STEP -1
180 SOUND 2,77,8,VOL
190 PRINT CHR$(155)!MOVES ROCKET UP
200 FOR R=1 TO 200:NEXT R
210 NEXT VOL
220 END
```

The above program is a demonstration of the SOUND statement. It decreases (by a loop) the volume of a distorted sound. The sound effect resembles a rocket taking off into outer space.

GAME CONTROLLERS

In ATARI Microsoft BASIC II, the PEEK instruction reads the game controllers. The controllers are attached directly to the controller jacks of the ATARI Home Computer. The PEEK locations can be given the same names listed below or you can give them short variable names. A complete list of PEEK locations is given in Appendix E.

You may also use the DEF command to define your own paddle and joystick controller commands (see the user-defined function, DEF, in Section 4).



JOYSTICK CONTROLLERS

PADDLE CONTROLLERS

Figure 6-1 Game Controllers

PADDLE CONTROLLERS

The following example program reads and prints the status of paddle controller 0 (first paddle in leftmost port). This PEEK can be used with other functions or commands to "cause" further actions like sound, graphics controls, and so on. An example is the statement IF PADDLE(0) >14 THEN GOTO 440. Peeking the paddle address returns a number between 1 and 228, with the number increasing in size as the knob on the controller is rotated counterclockwise (turned to the left).

Example of initializing and using PEEK for PADDLE(0):

```
10 PADDLE(0) = 624
20 PRINT PEEK (PADDLE(0))
30 GOTO 20
```

PADDLE number and PEEK locations (decimal addresses):

PADDLE(0) = 624
PADDLE(1) = 625
PADDLE(2) = 626
PADDLE(3) = 627
PADDLE(4) = 628
PADDLE(5) = 629
PADDLE(6) = 630
PADDLE(7) = 631

Peeking the following addresses returns a status of 0 if you press the trigger button of the designated controller. Otherwise, it returns a value of 1.

Example of using paddle trigger (0):

```
10 PTRIG(0) = &27C
20 PRINT PEEK(PTRIG(0))
30 GOTO 20
```

PTRIG (paddle trigger) number and PEEK locations (decimal addresses):

PTRIG(0) = 636
PTRIG(1) = 637
PTRIG(2) = 638
PTRIG(3) = 649
PTRIG(4) = 640
PTRIG(5) = 641
PTRIG(6) = 642
PTRIG(7) = 643

JOYSTICK CONTROLLERS

Peeking the joystick locations (addresses) works in the same way as for the paddle controllers. The joystick controllers are numbered 0-3 from left to right.

Example of using joystick (0):

```
10 STICK(0) = 632
20 PRINT PEEK(STICK(0))
30 GOTO 20
```

STICK (joystick) number and PEEK (decimal) locations:

STICK(0) = 632
STICK(1) = 633
STICK(2) = 634
STICK(3) = 635

Figure 6-2 shows the PEEK number that is returned for the various joystick positions:

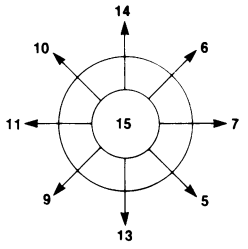


Figure 6-2 Joystick Triggers

The joystick triggers work the same way as the paddle trigger buttons.
Using joystick trigger (0):

```
10 STRIG(0) = 644
20 PRINT PEEK(STRIG(0))
30 GOTO 20
```

STRIG (joystick trigger) number and PEEK (decimal) locations:
STRIG(0) = 644
STRIG(1) = 645
STRIG(2) = 646
STRIG(3) = 647

```
10 REM THIS PROGRAM WILL SAY "BANG!"
15 REM WHEN JOYSTICK RED BUTTON IS PRESSED
20 IF PEEK(644) = 0 THEN ? "Bang!"
30 IF PEEK(644) = 1 THEN CLS
40 GOTO 20
```

SPECIAL FUNCTION KEYS

The following program reads the large yellow console keys on the right-hand side of the ATARI Computer:

```
10 POKE 53279,0
20 PRINT PEEK(53279)
30 GOTO 20
```

Peeking location 53279 (decimal) returns a number that indicates which key was pressed.
7 = No key pressed
6 = **START** key pressed
5 = **SELECT** key pressed
3 = **OPTION** key pressed

PLAYER-MISSILE GRAPHICS TUTORIAL 7

The ATARI Home Computer has special powers built in to deal with graphics and animation. These are usually referred to as player-missile graphics.

The terms *player* and *missile* are derived from the animated graphics used in ATARI video games. Player-missile binary tables reside in player-missile graphics RAM. This RAM accommodates four 8-bit players and four 2-bit missiles (see Figure 7-1). Each missile is associated with a player, unless you elect to combine all missiles to form a fifth, independent player (see "Priority Control").

A player, like the spaceship shown in Figure 7-2, is displayed by mapping its binary table directly onto the television screen, on top of the playfield. The first byte in the table is mapped onto the top line of the screen, the second byte onto the second line, and so forth. Wherever 1's appear in the table, the screen pixels turn on; wherever 0's appear, the pixels remain off. The pattern of light and dark pixels creates the image.

You can display player-missile graphics with single-line resolution (use OPTION(PLM1)) or double-line resolution (OPTION(PLM2)). If you select single-line resolution, each byte of the player is displayed on a single scan line. If you choose double-line resolution, each byte occupies two scan lines and the player appears larger than in single-line resolution. Each player is 256 bytes long with single-line resolution, or 128 bytes long with double-line resolution. Line resolution only needs to be programmed once. The resolution you choose applies to all player-missile graphics in your program. The Player-Missile Graphics Demonstration Program included in this section is an example of double-line resolution programming.

Player-missile graphics give you considerable flexibility in programming animated video graphics. Registers are provided for player-missile color, size, horizontal positioning, player-playfield priority, and collision control.

The following BASIC II commands are tools to help you construct and move players and missiles:

MOVE instruction
OPTION (PLM1 or PLM2)
VARPTR (PLM1 or PLM2)
SETCOLOR 0 or 1 or 2 or 3

HOW ATARI MICROSOFT BASIC II INSTRUCTIONS ASSIST PLAYER-MISSILE GRAPHICS

The MOVE instruction is used to move the player-missile object up and down the player-missile strip. Your paper strip can serve to demonstrate how the MOVE instruction works. Let's say that you have put the upside down V on your paper strip with a pencil that has an eraser. To move the object, you must erase the whole object and rewrite it elsewhere on the strip.

As you can imagine, vertical movement is slightly slower than horizontal movement. It is slower because it takes only a single poke to the horizontal position register for horizontal movement, but many erasures and redrawings are necessary to move an object vertically.

In the actual MOVE instruction you state the lowest address of the object you want to move; then state the lowest address of the new area to which you want to move the object; and lastly, state how many bytes you want moved. Hence the format: MOVE from_address, to_address, no._of_bytes.

The OPTION (PLM1) zeros out and dedicates a single-line resolution player-missile area in RAM. OPTION (PLM2) is for double-line player-missile resolution.

VARPTR(PLM1 or PLM2) points to the beginning memory location of the player-missile area in RAM. This is the point from which you must figure your offset or displacement to poke your image into the correct area. For example, the starting address (top of television screen) for player 0 in double-line resolution is VARPTR(PLM2) + 128. In double-line resolution each player is 128 bytes long. So if you wanted to poke a straight line in the middle of player 0, the poke would be POKE VARPTR(PLM2) + 192,&FF.

The SETCOLOR instruction gives the register, color, and luminance assignments. In ATARI Microsoft BASIC II the registers 0, 1, 2, and 3 are used for player-missiles 0, 1, 2, and 3. It is only necessary to specify SETCOLOR 0,5,10 to set player-missile 0; the COLOR instruction is not used.

Remember that you must poke decimal location 559 with decimal 62 for single-line resolution or with decimal 46 for double-line resolution. You must also poke decimal location 53277 with decimal 3 to enable player-missile display.

You can use player-missile graphics in all modes. Missiles consist of 2-bit-wide "strips." Missiles 0, 1, 2, 3 are assigned the same colors as their associated player. Thus, when SETCOLOR sets the color of player 1 to red, it also sets missile 1 to red.

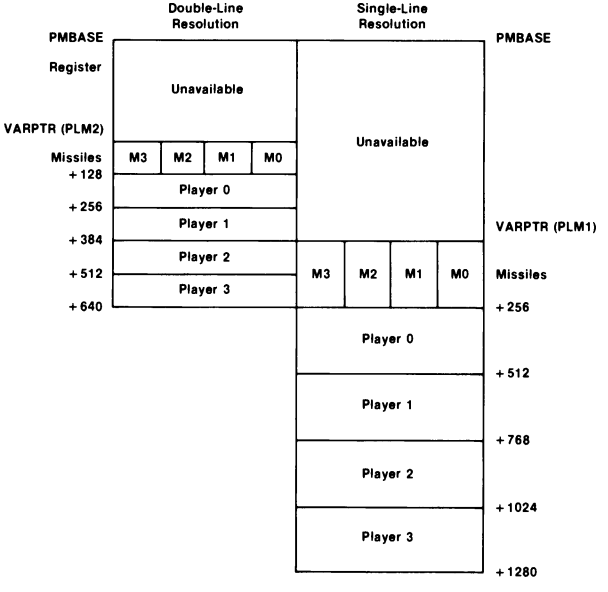


Figure 7-1 Player-Missile Graphics RAM Configuration

MAKING A PLAYER OUT OF PAPER

Cut a strip of paper about 2 inches wide from an 8-inch by 10-inch sheet of paper. Now draw an 8-bit-wide "byte" down the strip of paper.

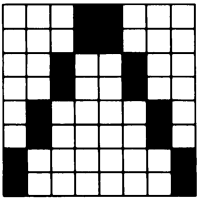
Graphic Representation	Binary Representation	Hexadecimal Representation	Decimal Representation
	00011000	18	24
	00011000	18	24
	00100100	24	36
	00100100	24	36
	01000010	42	66
	01000010	42	66
	10000001	81	129
	10000001	81	129

Figure 7-2 Mapping the Player

An upside down V is shown on the strip in binary and hex. This strip of paper is like a player. If you take the player strip and lay it vertically down the middle of the television screen, you have "positioned it with the horizontal position register." When you move the strip right and left, you are "poking new locations into the horizontal position register" to get that movement.

COLOR CONTROL

The ATARI Computers have nine registers for user control of player-missile, playfield, and background color (see Table 7-1).

TABLE 7-1 SETCOLOR REGISTER ASSIGNMENTS

SETCOLOR Register,Color,Luminance	Function
SETCOLOR 0,color,luminance	Color-luminance of player-missile 0
SETCOLOR 1,color,luminance	Color-luminance of player-missile 1
SETCOLOR 2,color,luminance	Color-luminance of player-missile 2
SETCOLOR 3,color,luminance	Color-luminance of player-missile 3
SETCOLOR 4,color,luminance	Color-luminance of playfield 0
SETCOLOR 5,color,luminance	Color-luminance of playfield 1
SETCOLOR 6,color,luminance	Color-luminance of playfield 2
SETCOLOR 7,color,luminance	Color-luminance of playfield 3
SETCOLOR 8,color,luminance	Color-luminance of background

Players are completely independent of the playfield and of each other. Missiles share color registers with their players and hence are the same color as their players. If you combine missiles to form a fifth player, they assume the color of playfield color-luminance register 3 (COLPF3).

To program color, specify the register, the hue, and the luminance. Use the SETCOLOR command. See lines 20 and 110 of the Player-Missile Graphics Demonstration Program for examples. See also "GRAPHICS," Section 6.

Each color-luminance register is independent. Therefore, you could use as many as nine different colors in a program, depending upon the graphics mode selected. All registers cannot be used in all graphics modes (see "GRAPHICS," Section 6).

SIZE CONTROL

Five size-control registers are provided—four for the players and one for all four missiles (see Table 7-2).

TABLE 7-2 REGISTERS CONTROLLING WIDTH OF PLAYER-MISSILES

Size Register	Address Hex	Dec	Function
SIZEP0	D008	53256	Controls size of player 0
SIZEP1	D009	53257	Controls size of player 1
SIZEP2	D00A	53258	Controls size of player 2
SIZEP3	D00B	53259	Controls size of player 3
SIZEM	D00C	53260	Controls size of missiles

Size-control registers allow you to double or quadruple the width of a player or missile without altering its bit resolution. To double the width, poke a 1 into the size register; to quadruple the width, poke a 3; and to return a player or missile to normal size, poke a 0 or 2. An example is given in line 80 of the Player-Missile Graphics Demonstration Program.

POSITION AND MOVEMENT

VERTICAL

Vertical position is set when you specify the location of the player-missile in player-missile graphics RAM. The lower you place the player-missile in RAM, the higher the image will be on the television screen. A positioning technique is illustrated by lines 120 and 200 of the Player-Missile Graphics Demonstration Program at the end of this section.

To program vertical motion, use the MOVE command (see lines 350 and 390 of the Player-Missile Graphics Demonstration Program). Since the MOVE command does not zero the old location after the move, an extra zero at each end of the player is used to "clean up" as the player is being moved. Give the current position of the player in RAM, the direction of the move through RAM (forward = +, backward = -), and the number of player bytes to be moved. Each byte of the player must be moved. Following the MOVE command, increment or decrement the vertical position counter (see lines 360 and 400 of the Player-Missile Graphics Demonstration Program).

HORIZONTAL

Each player and missile has its own horizontal position register (Table 7-3), so players can move independently of each other, and missiles can move independently of their players.

TABLE 7-3 PLAYER-MISSILE HORIZONTAL POSITION REGISTERS

Position Register	Address Hex	Dec	Function
HPOSP0	D000	53248	Horizontal position of player 0
HPOSP1	D001	53249	Horizontal position of player 1
HPOSP2	D002	53250	Horizontal position of player 2
HPOSP3	D003	53251	Horizontal position of player 3
HPOSM0	D004	53252	Horizontal position of missile 0
HPOSM1	D005	53253	Horizontal position of missile 1
HPOSM2	D006	53254	Horizontal position of missile 2
HPOSM3	D007	53255	Horizontal position of missile 3

To set the position of a player or missile, poke its horizontal position register with the number of the position. To program horizontal movement, simply change the number stored in the register. See lines 100 and 180 of the Player-Missile Graphics Demonstration Program for examples.

A horizontal position register can hold 256 positions, but some of these are off the left or right margin of the television screen. A conservative estimate of the range of player visibility is horizontal positions 60 through 200. The actual range depends upon the television set.

DIAGONAL

Horizontal and vertical moves can be combined to move the player diagonally. Set the horizontal position first, then the vertical position. See lines 270 through 390 of the Player-Missile Graphics Demonstration Program.

PRIORITY CONTROL

The priority control register (PRIOR,&D01B; OS shadow GPRIOR,&26F) enables you to select player or playfield color register priority and to combine missiles to form a fifth player.

PRIORITY SELECT

You have the option to specify which image has priority in the event player and playfield images overlap. This feature enables you to make players disappear behind the playfield and vice versa. To set the priority, poke one of the following numbers into the priority control register:

1 = All players have priority over all playfields.
2 = Players 0 and 1 have priority over all playfields, and all playfields have priority over players 2 and 3.
4 = All playfields have priority over all players.
8 = Playfields 0 and 1 have priority over all players, and all players have priority over playfields 2 and 3.

ENABLE FIFTH PLAYER

Setting bit D4 of the priority control register causes all missiles to assume the color of playfield register 3 (&2C7, decimal 711). You can then combine the missiles to form a fifth player. If enabled, the fifth player must still be moved horizontally by changing all missile registers (&D004 through &D007) together.

COLLISION CONTROL

Collision control enables you to tell when a player or missile has collided with another graphics object. There are 16 collision-control registers (Table 7-4).

TABLE 7-4 COLLISION-CONTROL REGISTERS FOR PLAYER-MISSILES

Collision Register	Address Hex	Dec	Function
M0PF	D000	53248	Missile 0 to playfield
M1PF	D001	53249	Missile 1 to playfield
M2PF	D002	53250	Missile 2 to playfield
M3PF	D003	53251	Missile 3 to playfield
P0PF	D004	53252	Player 0 to playfield
P1PF	D005	53253	Player 1 to playfield
P2PF	D006	53254	Player 2 to playfield
P3PF	D007	53255	Player 3 to playfield
M0PL	D008	53256	Missile 0 to player
M1PL	D009	53257	Missile 1 to player
M2PL	D00A	53258	Missile 2 to player
M3PL	D00B	53259	Missile 3 to player
P0PL	D00C	53260	Player 0 to player
P1PL	D00D	53261	Player 1 to player
P2PL	D00E	53262	Player 2 to player
P3PL	D00F	53263	Player 3 to player

In each case, only the rightmost 4 bits of each register are used. They are numbered 0, 1, 2, and 3 from the right and designate, by position, which playfield or player the relevant player or missile has collided with. A 1 in any bit position indicates collision since the last HITCLR.

All collision registers are cleared at once by writing a zero to the HITCLR register (&D01E, decimal 53278).

PLAYER-MISSILE GRAPHICS DEMONSTRATION PROGRAM

The following ATARI Microsoft BASIC II program creates a player (spaceship) that shoots missiles and can be moved in all directions with the joystick. Connect a joystick controller to CONNECTOR JACK 1 on the front of your ATARI Home Computer.

LISTING

```
05 !DOUBLE-LINE RESOLUTION PLAYER AND MISSILE
10 GRAPHICS 8
20 SETCOLOR 6,0,0
30 X = 130
40 Y = 70
50 STICK0 = &278
60 OPTION PLM2
70 POKE 559,46
80 POKE &D00C,1
90 POKE &D01D,3
100 POKE &D000,X
110 SETCOLOR 0,3,10
120 FOR J = VARPTR(PLM2) + 128 + Y TO VARPTR(PLM2) + 135 + Y:READ
A:POKE J,A
```

```
125 NEXT J
130 DATA 0,129,153,189,255,189,153,0
140 IF PEEK(&D010) = 1 THEN 220
150 SOUND 0,220,12,15,INT(X/30)
160 ZAP = X
170 POKE VARPTR(PLM2) + 4 + Y,3
180 POKE &D004,ZAP
190 ZAP = ZAP-12
200 IF ZAP < 12 THEN POKE VARPTR(PLM2) + 4 + Y,0:GOTO 220 ELSE 180
210 !JOYSTICK MOVES
220 A = PEEK(STICK0): IF A = 15 THEN GOTO 140
230 IF A = 11 THEN X = X-1
240 IF A = 7 THEN X = X+1
250 POKE &D000,X
260 IF A = 14 THEN GOTO 350 !MOVE UP
270 IF A = 13 THEN GOTO 390 !MOVE DOWN
280 !MOVE DIAGONALLY
290 IF A = 10 THEN X = X-1:POKE &D000,X:GOTO 350
300 IF A = 6 THEN X = X+1:POKE &D000,X:GOTO 350
310 IF A = 9 THEN X = X-1:POKE &D000,X:GOTO 390
320 IF A = 5 THEN X = X+1:POKE &D000,X:GOTO 390
330 GOTO 140
340 !MOVE UP
350 MOVE VARPTR(PLM2) + 128 + Y,VARPTR(PLM2) + 128 + (Y-1),8
360 Y = Y-1
370 GOTO 140
380 !MOVE DOWN
390 MOVE VARPTR(PLM2) + 128 + (Y-1),VARPTR(PLM2) + 128 + Y,8
400 Y = Y+1
410 GOTO 140
420 STOP
430 END
```

ANNOTATION

Line Number	Comment
10	Sets a high-resolution graphics mode with no text window. You can program player-missile graphics in any graphics mode. See "GRAPHICS" and Table 6-4 in Section 6.
20	Sets the background color to black, as follows: 6 = Background color-luminance register (COLBK, &D01A). 0 = Black (see Table 6-3). 0 = Zero luminance. The luminance value is an even number between 0 and 14. The higher the number, the greater the luminance and the brighter the color.
30,40	Initializes player-position variables X (horizontal) and Y (vertical).
50	Assigns the label STICK0 to joystick register 278.
60	Specifies double-line resolution RAM for the player-missile graphics (see Figure 7-1). PLM1 would specify single-line resolution.

70 Sets the direct memory access control register (DMACTL, 559) for double-line resolution (46). A 62 would specify single-line resolution.

Note: When DMACTL is enabled, the player-missile graphics registers (GRAFP0-GRAFP3 and GRAFM) are automatically loaded with data from the player-missile RAM.

80 Doubles the width of the missile by poking the size-control register (SIZEM, &D00C) with 1. Poking the register with a 3 would quadruple the width.

90 Enables the graphics control register (GRACTL, &D01D) to display player-missile graphics (3 enables, 0 disables).

100 Pokes the horizontal position of the player (X = 130 from line 30) into the player 0 horizontal position register (HPOSP0, &D000).

110 Colors the player and missile bright red-orange as follows:
0 = Player-missile 0 color-luminance register (COLPM0, &D012).
3 = Red-orange (see Table 6-3).
10 = Luminance or brightness (see annotation of line 20).

120-125 Sets variable pointer VARPTR(PLM2) to the player-missile starting address in player-missile graphics RAM (see Figure 7-2). Pokes data from line 130 into the player area, VARPTR(PLM2) + 128 + Y to VARPTR(PLM2) + 135 + Y. The computer uses the data in line 130 to map the spaceship onto the screen (see Figure 7-2).

140 Tells the computer to read the joystick 0 trigger register (TRIG0, &D010). If the trigger button is not activated (&D010 = 1), the computer goes to line 220 and reads the joystick position; if the button is activated (&D010 = 0), the computer executes lines 150 through 200.

150 Generates sound each time the joystick button is pressed. Sound is programmed as follows:
(1) Select voice. As many as four voices (0 to 3) can be used, but each voice requires a separate SOUND statement.
(2) Choose pitch from Table 7-2. The larger the number, the lower the pitch.
(3) Set distortion or noise level, using an even number between 0 and 14. A 10 gives a pure tone; 12 gives a buzzer effect.
(4) Set volume, an odd number between 1 and 15. The larger the number, the louder the sound.
(5) Set duration of sound per second (20 = 20/60 or 1/3 second).

160 Sets the horizontal position of the missile (ZAP) equal to the horizontal position of the player (X).

170 Turns on the screen pixels corresponding to the missile 0 RAM area (VARPTR(PLM2) + 4 + Y) to display the missile (3 = ON; 0 = OFF).

180 Pokes the horizontal position of the missile (ZAP = X from line 160) into the missile 0 horizontal position register (HPOSM0, &D004).

190 Decrements the missile 0 horizontal position counter by 12 to create a horizontal "line of fire" from the player.

200	If the missile's horizontal position is less than 12 (off the left side of the screen), the computer pokes 0's into the missile RAM area to clear it and goes to line 220. If the missile's horizontal position is 12 or greater, the computer pokes the new horizontal position into HPOSM0 (register &D004 in line 180) and decrements the horizontal position counter by 12 (line 190).
220	Tells the computer to read the STICK0 register and find the position of the joystick (see Figure 6-1). If the position is 15 (neutral), the computer goes to line 140 and reads the joystick trigger register (&D010).
230/250	If the joystick is moved left (11), the computer decrements the horizontal position counter and pokes the spaceship's new horizontal position into the HPOSP0 register (&D000).
240/250	If the joystick is moved right (7), the computer increments the horizontal position counter and pokes the spaceship's new horizontal position into HPOSP0.
260	If the joystick is moved up (14), the computer moves the spaceship back one byte in player-missile RAM (line 350). Each of the 8 bytes that comprise the spaceship must be moved back. When the move is completed, the computer decrements the vertical position counter (line 360).
270	If the joystick is moved down (13), the computer advances the spaceship one byte in player-missile RAM (line 390) and increments the vertical position counter (line 400).
290-320	If the joystick is moved diagonally (10, 6, 9, or 5), the computer executes a horizontal move (after resetting the horizontal position register), makes a vertical move (line 350 or 390), and resets the vertical position counter (line 360 or 400).

A APPENDIX SAMPLE PROGRAMS

DISK DIRECTORY PROGRAM

Features used:

- User-callable CIO routines (CIOUSR) (See Appendix L.)
- Integers
- VARPTR function
- ON ERROR
- On-line comments

```
10 !                                    ROUTINE TO READ
20 !                                    DISK DIRECTORY
30 !
40 ON ERROR 350
50 OPTION RESERVE(200)                  !GET SPACE FOR CIOUSR ROUTINES
60 OPEN#1,"D:CIOUSR" INPUT              !OPEN FILE
80 ADDR = VARPTR(RESERVE)               !GET STARTING ADDRESS OF
                                        RESERVED AREA
90 FOR I = 0 TO 159                     !POKE IN CIOUSR ROUTINES
100 GET#1,D:POKE ADDR + I,D
110 NEXT I
120 CLOSE #1
130 PUTIOCB = ADDR                      !THESE ARE THE PROPER STARTING
                                        POINTS
140 CALLCIO = ADDR + 61                 !FOR EACH OF THE
150 GETIOCB = ADDR + 81                 !ROUTINES
160 DIM IOCB%(10)                       !DATA FOR ROUTINES TAKES 10
                                        BYTES
170 IOCB%(0) = 1                        !USE IOCB #1
180 IOCB%(1) = 3                        !DO A CIO "OPEN" CALL
190 IOCB%(5) = 6                        !FOR DIRECTORY INPUT
200 FSPEC$ = "D:*.*"                    !DIR FILE SPEC
210 !                                   !PUT ADDRESS OF FSPEC INTO
                                        BUFFER
220 Z = VARPTR(FSPEC$)                  !ADDRESS OF THE STRING
                                        FILESPEC
230 Y = VARPTR(IOCB%(3))                !ADDRESS OF THE PROPER ARRAY
                                        POSITION
240 POKE Y,PEEK(Z + 2)                  !HIGH ADDRESS BYTE
250 POKE Y + 1,PEEK(Z + 1)              !LOW ADDRESS BYTE
260 !                                   PUTDATA INTO IOCB
270 Z = USR(PUTIOCB,VARPTR(IOCB%(0)))
280 !                                   THEN CALL CIO
290 Z = USR(CALLCIO,VARPTR(IOCB%(0)))
300 !                                   IOCB IS SETUP AND DISK
310 !                                   IS OPEN...READ DIRECTORY
```

```
320 INPUT #1,S$
330 PRINT S$
340 GOTO 320
350 CLOSE #1
360 END
```

EXPLOSION SUBROUTINE

Feature used: Sound

```
10 !TWO-LINE MAIN PROGRAM
20 !AND SUBROUTINE TO PRODUCE
30 !AN EXPLOSION
40 !
50 GOSUB 8000
60 STOP
8000 !
8010 !EXPLOSION SUBROUTINE
8020 !
8030 SOUND 2,75,8,14
8040 ICR = 0.79
8050 V1 = 15:V2 = 15:V3 = 15
8060 SOUND 0,NTE,8,V1
8070 SOUND 1,NTE + 20,8,V2
8080 SOUND 2,NTE + 50,8,V3
8090 V1 = V1 * ICR
8100 V2 = V2 * (ICR + .05)
8110 V3 = V3 * (ICR + .08)
8120 IF V3 >1 THEN 8060
8130 SOUND 0,0,0,0,0
8140 SOUND 1,0,0,0,0
8150 SOUND 2,0,0,0,0
8160 RETURN
```

FANFARE MUSIC EXAMPLE

Feature used: Sound with duration

```
10 !ROUTINE TO GENERATE FANFARE MUSIC
20 !TWO-LINE MAIN PROGRAM
30 !
40 GOSUB 8000
50 STOP
8000 !
8010 !FANFARE MUSIC
8020 !
8030 DUR = 20:V0 = 181:V1 = 144:V2 = 121:GOSUB 8200
8040 DUR = 7:GOSUB 8200
8050 GOSUB 8200
8060 DUR = 9:V0 = 162:V1 = 128:V2 = 108:GOSUB 8200
8070 DUR = 15:V0 = 181:V1 = 144:V2 = 121:GOSUB 8200
8080 V0 = 162:V1 = 128:V2 = 108:GOSUB 8200
8090 V0 = 153:V1 = 128:V2 = 96:V3 = 193
8100 For I = 2 TO 14
8110 SOUND 3,V0,10,I
```

```
8120 SOUND 1,V1,10,I
8130 SOUND 2,V2,10,I
8140 SOUND 0,V3,10,I
8150 FOR J = 1 TO 100:NEXT J
8160 NEXT I
8170 FOR J = 1 TO 200:NEXT J
8180 SOUND 0,0,0,0
8185 SOUND 1,0,0,0
8190 SOUND 2,0,0,0
8195 SOUND 3,0,0,0
8197 RETURN
8200 !SOUND GENERATOR
8210 SOUND 0,V0,10,8,DUR
8220 SOUND 1,V1,10,8,DUR
8230 SOUND 2,V2,10,8,DUR
8240 !
8250 !NOW STOP THE SOUND
8260 !
8270 SOUND 0,0,0,0
8280 SOUND 1,0,0,0
8290 SOUND 2,0,0,0
8295 FOR J = 1 TO 250:NEXT J
8300 RETURN
```

EXAMPLE OF ATARI PIANO

Features used:

- OPEN statement
- String array
- INKEY$
- SOUND
- On-line comments

```
10 !EXAMPLE PROGRAM TO
20 !CONVERT YOUR ATARI
30 !COMPUTER INTO A PIANO!
40 !
50 !
60 !FIRST, SET UP A 2-OCTAVE
70 !SCALE OF KEYS TO PRESS
80 !AND NOTES TO PLAY
90 DIM NOTES$(15)
100 DIM PITCH(15)
110 !NOW READ THESE INTO
120 !THEIR RESPECTIVE TABLES
130 OPEN #1, "D:NOTES.DAT" INPUT
140 FOR I = 1 TO 15
150 INPUT #1,S$,P
160 NOTES$(I) = S$:PITCH(I) = P
170 NEXT I
180 CLOSE #1
190 PRINT "PLAY,BURT,PLAY!"
200 !
210 !BEGIN TESTING FOR KEYS
```

```
220 !BEING PRESSED
230 !
240 N$ = INKEY$
250 IF N$ = "" THEN GOTO 240 ELSE GOTO 320
260 !
270 !WHEN A KEY IS PRESSED,
280 !SEE IF ITS ONE ON OUR
290 !PIANO KEYBOARD!
300 !
310 !
320 FOR I = 1 TO 15
330 IF N$ = NOTES$(I) GOTO 380
340 NEXT I
350 GOTO 240 !NOT A GOOD KEY, TRY AGAIN
360 !FOUND A GOOD KEY, PROCESS IT
370 !
380 VOLUME = 8
390 SOUND 1,PITCH(I),10,VOLUME,15
400 GOTO 240
410 END
```

Sample NOTES.DAT FILE:

- First item is the key to be pressed
- Second item is the frequency to play

```
10 !PROGRAM TO CREATE NOTES.DAT FILE
20 !
30 DIM NOTES$(15),PITCH(15)
40 FOR I = 1 TO 15
50 INPUT "ENTER KEY, FREQ. FOR KEY:";NOTES$(I),PITCH(I)
60 NEXT I
70 OPEN #1,"D:NOTES.DAT" OUTPUT
80 FOR I = 1 TO 15
90 PRINT #1,NOTES$(I);",";PITCH(I)
100 NEXT I
110 CLOSE #1
120 END
```

Enter the following values to get a 2-octave scale:

Z, 243
X, 217
C, 193
V, 182
B, 162
N, 144
M, 128
A, 121
S, 108
D, 96
F, 91
G, 81
H, 72
J, 64
K, 60

DECIMAL-TO-HEX CONVERSION ROUTINE

Features used:

- String array
- Integers
- On-line comments

```
20 !
30 !DECHEX
40 !
50 !
60 !
70 !PROGRAM TO CONVERT AN INPUT
80 !DECIMAL NUMBER TO ITS
90 !HEXADECIMAL EQUIVALENT
100 !
110 !
130 DIM HEX$(15):DIM HEXBASE(4)
140 FOR I = 0 TO 15
150 READ HEX$(I)
160 NEXT I
170 FOR I = 0 TO 4
180 READ HEXBASE(I)
190 NEXT I
200 DATA 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F
210 DATA 0,4096,256,16,1
220 !
230 !GET THE DECIMAL NO.
240 !
250 INPUT "ENTER THE DECIMAL NO.:";DEC
260 IF DEC = 0 THEN 500 !STOP
270 !
280 !PROCESS EACH HEX DIGIT
290 !
300 FOR J = 1 TO 4
305 IF J = 4 THEN ANS% = DEC:GOTO 350
310 ANS% = (DEC/HEXBASE(J))-.5
320 IF ANS% < 1 THEN ANS% = 0
330 DEC = DEC-(ANS% * HEXBASE(J))
340 !
350 !FIND THE HEX DIGIT FOR FIRST POSITION
360 FOR I% = 0 TO 15
370 IF ANS% = I% THEN GOTO 420
380 NEXT I%
390 !IF WE GOT HERE ITS AN ERROR!
400 PRINT " DECIMAL INPUT CAN'T BE COMPUTED"
410 PRINT "PLEASE TRY AGAIN": GOTO 250
420 HEXNO$ = HEXNO$ + HEX$(I%)
430 NEXT J
440 !
450 !PRINT THE HEX NO. AND GO FOR ANOTHER
460 !
```

```
470 PRINT "HEX NO. = ";HEXNO$
480 HEXNO$ = ""
490 GOTO 250
500 END
```

VERTICAL FINE SCROLLING

Features used:

- Fine scrolling
- VARPTR
- OPTION RESERVE and CHR
- User-defined display list

```
10 DEFINT A-Z
20 OPTION RESERVE(3000)                          !AREA FOR SCREEN RAM
30 OPTION CHR1                                   !AREA FOR DISPLAY LIST
40 ADDR = VARPTR(CHR1)
50 CADDR = VARPTR(RESERVE)
60 VSCROL = &D405                                !VERTICAL SCROLL REGISTER
70 LCADDR = 0
80 HCADDR = ((CADDR AND &FF00)/256) and &FF
90 FOR I = 0 TO 99                !ZERO THE DISPLAY LIST AREA (1ST 100 BYTES)
100 POKE ADDR + I,0:NEXT I
110 LADDR = ADDR AND &FF
120 HADDR = ((ADDR AND &FF00)/256) AND &FF
130 LMSLO = ADDR + 4                             !ADDRESS OF LOAD
140 LMSHI = ADDR + 5                             !MEMORY SCAN BYTES (LMS)
150 FOR I = 0 TO 18                              !POKE IN NEW DISPLAY LIST
160 READ D                                       !FROM DATA STMTS. 190-210
170 POKE ADDR + I,D
180 NEXT I
190 DATA &70,&70,&70,&67,&00,&00,&27,&27
200 DATA &27,&27,&27,&27,&27,&27,&27,&27
210 DATA &27,&07,&41
220 POKE ADDR + 19,LADDR                         !LAST 2 BYTES POINT BACK
230 POKE ADDR + 20,HADDR                         !TO TOP OF DISPLAY LIST
240 POKE LMSLO,LCADDR:POKE LMSHI,HCADDR          !TELLS SCREEN RAM START
250 K = -1                                       !250 - 320 LOAD DATA INTO
260 FOR I = 1 TO 300                             !SCREEN RAM AREA, A PAGE FULL
270 K = K + 1:POKE CADDR + K,33                  !OF A's AND THEN THE ALPHABET
280 NEXT I
290 FOR I = 34 TO 58
300 FOR J = 1 TO 20
310 K = K + 1:POKE CADDR + K,I
320 NEXT J,I
330 POKE &22F,0                                  !TURN OFF ANTIC
340 POKE &230,LADDR                              !TELL IT WHERE MY DISPLAY
350 POKE &231,HADDR                              !LIST IS, AND ...
360 POKE &22F,&22                                !TURN ANTIC BACK ON
370                                              !HERE IS THE REAL PROGRAM
380 FOR I = 1 TO 15                              !380 - 410 DO THE VERTICAL
390 POKE VSCROL, I                               !FINE SCROLL
400 FOR W = 1 TO 30:NEXT W
410 NEXT I
```

```
420 CADDR = CADDR + 20                          !CALCULATE WHERE NEXT LINE OF
430 LCADDR = CADDR AND &FF                      !SCREEN RAM STARTS
440 HCADDR = ((CADDR AND &FF00)/256) AND &FF    !FOR THE COARSE SCROLL
450 WAIT &D40B,&FF,96           !WAIT UNTIL TV VERTICAL LINE COUNTER HITS 96
460 POKE VSCROL,0        !THEN SET CHARACTERS BACK TO ORIGINAL POSITION
470 POKE LMSLO,LCADDR                                   !AND COARSE
480 POKE LMSHI,HCADDR     !SCROLL BY CHANGING LMS BYTE IN DISPLAY LIST
490 GOTO 380
```

PROGRAMS FOR GRAPHICS MODES

APPENDIX B

MICROBE INVASION EXAMPLE

```
10 REM MICROBE INVASION
15 REM SPIRAL CREATURES TAKE OVER SCREEN
16 REM 10 PERCENT CHANCE SCREEN CHANGES MODE
17 REM WHEN CREATURE GOES OUT OF BOUNDS
30 RANDOMIZE
40 MODE = RND(8)
50 GRAPHICS MODE + 16
60 PIX = RND(15)
70 SETCOLOR 0,PIX,6
80 COLOR 1
90 BAK = RND(255)
100 POKE 712,BAK
110 X = RND(150):Y = RND(100)
120 IF X >140 THEN 40
130 Z = 2
140 NUM = NUM + 1
150 FOR DOTS = 1 TO Z
160 IF NUM = 5 THEN NUM = 1
170 ON ERROR GOTO 230
180 PLOT X,Y
190 ON NUM GOSUB 250,270,290,310
200 NEXT
210 Z = Z + 1
220 GOTO 140
230 GRAPHICS MODE + 32 + 16!NO TEXT WINDOW,NO SCREEN CLEAR
240 RESUME 60
250 X = X + 1:Y = Y + 1
260 RETURN
270 X = X + 1:Y = Y-1
280 RETURN
290 X = X-1:Y = Y-1
300 RETURN
310 X = X-1:Y = Y + 1
320 RETURN
```

TOP SECRET PROGRAM

The following short program makes use of RANDOMIZE and RND to print three-letter words and three-letter abbreviations of government agencies.

```
10 RANDOMIZE                                    !Seeds the RND function
20 GRAPHICS 2 + 16
30 X = RND(26) + 96                             !Make first letter
40 Y = RND(5)                                   !Make a vowel for middle letter
50 IF Y = 1 THEN Y = 97                         !Make an A
60 IF Y = 2 THEN Y = 101                        !Make an E
70 IF Y = 3 THEN Y = 105                        !Make an I
80 IF Y = 4 THEN Y = 111                        !Make an O
90 IF Y = 5 THEN Y = 117                        !Make a U
100 Z = RND(26) + 96                            !Make last letter
110 PRINT #6, AT(9,3)CHR$(X);CHR$(Y);CHR$(Z)
120 FOR DELAY = 1 TO 2000:NEXT
180 GOTO 30
```

ALTERNATE CHARACTER SETS

APPENDIX C

ATARI Home Computers support several standard character sets that are stored as part of the Operating System (OS) ROM. These include all the upper- and lower-case alphabet, numbers, special characters, and a special graphics character set. At times, however, it is very useful to be able to define your own character set. Applications for this capability that immediately come to mind include character-driven animation, foreign language word processing, and background graphics for games (for instance, a map or special playfield).

ATARI Computers and ATARI Microsoft BASIC II readily support this need. This is easy for the ATARI Home Computer because the OS data base contains a pointer (CHBAS) at hex location 2F4 (decimal location 756) that points to the character set to be used. Normally this points at the standard character set in the OS ROM. But in BASIC, you can POKE your own character set into a free area of RAM (set aside with the OPTION CHR1 or OPTION CHR2 statement) and then reset the OS pointer, CHBAS, to point to your new character set. The computer instantly begins using the new characters.

There are several important things to keep in mind when redefining the character set:

- Graphics mode 0 needs 128 characters defined (OPTION CHR1). Graphics modes 1 and 2 allow only 64 characters (OPTION CHR2).
- All 64 or 128 characters need to be defined even though you may only wish to change and use one character; this is easily accomplished by transferring the ROM characters into your RAM area and then changing the desired character to its new configuration.
- The 64-character set requires 512 bytes of memory (8 bytes per character) and must start on a ½K boundary. The 128-character set requires 1024 bytes of memory and must start on a 1K boundary. You need not worry about these restrictions when using the CHR1 and CHR2 options; the area is allocated to begin on the proper boundary.
- The value that is poked into CHBAS after the character set is defined is the page number in memory where the character set begins. This value can be computed with the following statement—

CHBAS% = (VARPTR(CHRn)/256) AND &FF

—where "n" is either 1 or 2. This value is then poked into location &2F4 (decimal 756).

The most time-consuming process in using an alternate character set is creating the characters. Each character consists of 8 bytes of memory, stacked one on top of the other (see Figure C-1). Visualize each character as an 8x8 square of graph paper. Darken the necessary square on the graph paper to create a character (see Figure C-2). Then, each row of the 8x8 square is converted from this binary representation (where each darkened square is a 1 and each blank square is a zero) to a hex or decimal number (see Figure C-2). These numbers are then poked into the appropriate bytes of the RAM area, from top to bottom in these figures, to define the character in RAM. The first 8 bytes of the reserved (OPTION CHR1 or CHR2) area define the zeroth character, the next 8 bytes define the first character, and so on. After transferring the standard character set from its ROM location to the reserved CHR1 or CHR2 area, any character you can redefine by finding its starting position in the area, then poking the new bytes into the starting byte and the next 7 bytes. After all necessary characters are redefined, poke the new page number into CHBAS and the new character immediately becomes active. Use BASIC PRINT statements to display the new characters; for instance, if you have redefined the "A" to be a solid block and use the statement, PRINT "A", the new character will be printed.

A little experimentation with this process quickly shows how powerful this capability can be. The program that follows is an example of character set redefinition.

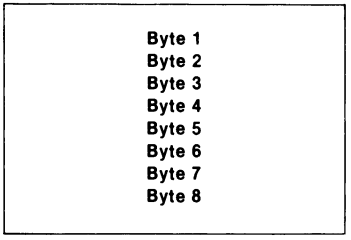


Figure C-1 Amount of Memory per Character

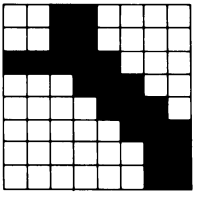
Byte No.		Binary	Hex	Decimal
1		00110000 =	30 =	48
2		00110000 =	30 =	48
3		11111000 =	F8 =	248
4		00011100 =	1C =	28
5		00001110 =	0E =	14
6		00000111 =	07 =	07
7		00000011 =	03 =	03
8		00000011 =	03 =	03

Figure C-2 Redefining a Character

Example Program:

```
10 !
20 !PROGRAM TO DEMONSTRATE
30 !ALTERNATE CHARACTER SET
40 !DEFINITION
50 !
60 !THE PROGRAM REDEFINES THE
70 !CHARACTERS A,B,C,D,E,F,G,H
80 !
90 CHBAS = &2F4 !CHARACTER SET POINTER
100 OPTION CHR1 !ALLOCATE CHARACTER SET AREA
110 ADDR% = VARPTR(CHR1) !FIND STARTING ADDRESS
120 PAGENO% = (ADDR%/256) AND &FF !CALCULATE PAGE
130 !
140 MOVE 57344,ADDR%,1024 !MOVE CHR. SET DOWN INTO RAM
150 !
150 OFFSET = 33*8 !OFFSET TO "A"
170 FOR I = 0 TO 63 !GET NEW CHARACTERS
180 READ C
190 POKE ADDR% + OFFSET + I,C !AND INSERT
200 NEXT I
210 !
220 !DATA STATEMENTS ARE BY CHARACTER
230 !
240 DATA &07,&0F,&1F,&3F,&7F,&FF,&FF,&FF
250 DATA &E0,&F0,&F8,&FC,&FE,&FF,&FF,&FF
260 DATA &FF,&FF,&FF,&7F,&3F,&1F,&0F,&07
270 DATA &FF,&FF,&FF,&FE,&FC,&F8,&F0,&E0
280 DATA &00,&00,&00,&EF,&7F,&FF,&FF,&FF
290 DATA &00,&00,&00,&FC,&FE,&FF,&FF,&FF
300 DATA &FF,&FF,&FF,&7F,&3F,&00,&00,&00
310 DATA &FF,&FF,&FF,&FE,&FC,&00,&00,&00
320 !
330 POKE CHBAS,PAGENO% !SWITCH TO NEW CHARACTER SET!
340 !
```

```
350 POKE &2F0,1 !TURN OFF CURSOR
360 SETCOLOR 6,2,6
370 X = 20
380 FOR Y = 10 TO 20
390 WAIT &D40B,&FF,110
400 CLS
410 PRINT AT(X,Y + 1);''CD''
420 FOR W = 1 TO 30:NEXT W
430 NEXT Y
440 CLS
450 PRINT AT(X,22);''GH''
460 SOUND 0,79,10,8,4
470 FOR W = 1 TO 80:NEXT W
480 FOR Y = 20 TO 10 STEP -1
490 WAIT &D40B,&FF,110
500 CLS
510 PRINT AT(X,Y + 1);''CD''
520 FOR W = 1 TO 30:NEXT W
530 NEXT Y
540 GOTO 380
```

INPUT/OUTPUT DEVICES

APPENDIX D

The keyboard, disk drive, program recorder, and modem are ways your computer gets information. These are called *input* devices. The ATARI Home Computer also gives information by writing it on the television screen, cassette tape, printer, or diskette, which are *output* devices.

ATARI input and output devices have identifying codes:

K: Keyboard. Input-only device. The keyboard allows the computer to get information directly from the console keys.

P: Line Printer. Output-only device. The line printer prints ATASCII characters, a line at a time.

C: Program Recorder. Input and output device. The recorder is a read/write device that can be used as either, but never as both simultaneously. The cassette has two tracks for sound and program recording purposes. The audio track cannot be recorded from the ATARI Computer system, but may be played back through the television speaker.

D1:,D2:,D3:,D4: Disk Drives. Input and output devices. If 32K of RAM is installed, the ATARI Computer can use four ATARI 810 Disk Drives. The default is D1: if no drive number is designated (D:).

E: Screen Editor. Input and output device. This device uses the keyboard and television screen (see **S: TV Monitor**) to simulate a video terminal. Writing to this device causes data to appear on the screen starting at the current cursor position. Reading from this device activates the screen-editing process and allows the user to enter and edit data. Whenever the **RETURN** key is pressed, the entire line is selected as the current record to be transferred by central input/output (CIO) to the user program. (Refer to the *ATARI Home Computer System Technical Reference Notes* for a detailed explanation of CIO.)

S: TV Monitor. Input and output device. This device allows you to read characters from and write characters to the screen, using the cursor as the screen-addressing mechanism. Both text and graphics operations are supported.

R: Interface, RS-232. The ATARI 850™ Interface Module enables the ATARI Computer system to interface with RS-232 compatible devices such as printers, terminals, and plotters.

E APPENDIX MEMORY LOCATIONS

Memory locations are expressed in hexadecimal, with decimal equivalents in parentheses. For additional information, see the *ATARI Home Computer System Technical Reference Notes*.

MEMORY MAP

The 6502 Microprocessor is divided into four basic memory regions: RAM, cartridge area, I/O chip region, and resident OS ROM. Memory regions and their address boundaries are listed below:

RAM (minimum required for operation):	0000-1FFF (0-8191)
RAM expansion area:	2000-7FFF (8192-32767)
Cartridge B (left cartridge) or 8K RAM:	8000-9FFF (32768-40959)
Cartridge A (right cartridge) or 8K RAM:	A000-BFFF (40960-49151)
Unused:	C000-CFFF (49152-53247)
I/O chips:	D000-D7FF (53248-55295)
OS floating point package:	D800-DFFF (55296-57343)
Resident operating system ROM:	E000-FFFF (57344-65535)

RAM REGION

The RAM region, shared by the OS and the program in control, is divided into the following subregions (see Table E-1 for some useful OS data base addresses).

- Page 0, 6502 Microprocessor Address Mode Region: 0000 through 00FF (0-255) allocated as follows:

  0000 through 007F (0-127): OS
  0080 through 00FF (128-255): User applications
  00D4 through 00FF (212-255): Floating point package, if used.

- Page 1, 6502 Hardware Stack Region: 0100 through 01FF (256-511).

Note: At power up or **SYSTEM RESET**, the stack location points to address 01FF (511) and the stack then pushes downward toward 0100 (256). The stack wraps around from 0100 to 01FF if a stack overflow occurs.

- Pages 2-4, OS Data Base (working variables, tables, data buffers): 0200 through 047F (512-1151).

- Pages 7-XX, User Boot Area: 0700 (1792) to start of free RAM area, where XX is a function of the screen graphics mode and the amount of RAM installed.

Note: When initial diskette startup is completed, the data base variable points to the next available location above the software loaded. When no software is entered by the initial diskette startup, the data base variable points to location 0700.

- Page XX to top of RAM, Screen Display List and Data: Data base pointer contains address of last available location below the screen area.

CARTRIDGE AREA

Cartridge B is the right cartridge on the ATARI 800 Home Computer. Cartridge A is the left cartridge on the ATARI 800 Home Computer and the only cartridge on the ATARI 400 Home Computer.

- Cartridge B: 8000 through 9FFF (32768-40959)
- Cartridge A: A000 through BFFF (40960-49151) for 8K cartridges; 8000 through BFFF (32768-49151) for 16K cartridges (optional)

Note: On the ATARI 800 Home Computer, if a RAM module plugged into the last slot overlaps any of these cartridge addresses, the installed cartridge disables the conflicting RAM module in 8K increments.

I/O CHIPS

The 6502 Microprocessor performs input/output operations by addressing the following external support chips as memory:

- GTIA/CTIA: D000 through D01F (53248-53279)
- POKEY: D200 through D21F (53760-53791)
- PIA: D300 through D31F (54016-54047)
- ANTIC: D400 through D41F (54272-54303)

Some of the chip registers are read/write; others are read only or write only. Table E-2 lists the registers and their addresses by chip. For additional information, see the *ATARI Home Computer System Technical Reference Notes*.

RESIDENT OS ROM

The region from D800 through FFFF (55296-65535) permanently contains the OS and the floating point package:

- Floating point package: D800 through DFFF (55296-57343)
- Operating System ROM: E000 through FFFF (57344-65535)

The OS contains many vectored entry points, all fixed, at the end of the ROM and in RAM. The floating point package is not vectored, but all documented entry points are fixed. (See the Appendix of the *ATARI Home Computer System Technical Reference Notes* for listings of the fixed ROM vectors and entry points.)

TABLE E-1 USEFUL OS DATA BASE ADDRESSES

Address Hex	Dec	Name	Byte Size	Function
MEMORY CONFIGURATION				
000E	14	APPMHI	2	User-free memory screen lower limit
006A	106	RAMTOP	1	Display handler top of RAM address (MSB)
02E4	740	RAMSIZ	1	Top of RAM address (MSB)
02E5	741	MEMTOP	2	User-free memory high address
02E7	743	MEMLO	2	User-free memory low address

TEXT/GRAPHICS SCREEN

Screen Margins (text modes; text window)

0052	82	LMARGN	1	Left screen margin (0-39; default 2)
0053	83	RMARGN	1	Right screen margin (0-39; default 39)

Cursor Control

0054	84	ROWSCRS	1	Current cursor row
0055	85	COLCRS	2	Current cursor column
005A	90	OLDROW	1	Prior cursor row
005B	91	OLDCOL	2	Prior cursor column
0290	656	TXTROW	1	Current cursor row in text window
0291	657	TXTCOL	2	Current cursor column in text window
02F0	752	CRSINH	1	Cursor display inhibit flag (0 = cursor on, 1 = cursor off)

Color Control

02C0	704	PCOLR0	4	Color-luminance player-missile 0
02C1	705	PCOLR1	4	Color-luminance of player-missile 1
02C2	706	PCOLR2	4	Color-luminance of player-missile 2
02C3	707	PCOLR3	4	Color-luminance of player-missile 3
02C4	708	COLOR0	5	Color-luminance of playfield 0
02C5	709	COLOR1	5	Color-luminance of playfield 1
02C6	710	COLOR2	5	Color-luminance of playfield 2
02C7	711	COLOR3	5	Color-luminance of playfield 3
02C8	712	COLOR4	5	Color-luminance of background

Attract Mode

004D	77	ATRACT	1	Attract mode timer and flag (Value 128 = on; turns on every 9 minutes)

Tabbing

02A3	675	TABMAP	15	Tab stop bit map (default: 7, 15, 23, and so on to 119)

Screen Memory

0058	88	SAVMSC	2	Upper left corner of screen

Split-Screen Memory

0294	660	TXTMSC	2	Upper left corner of text window

DRAW/FILL Function

02FD	765	FILDAT	1	Fill data for graphics FILL command

Internal Character Code Conversion

02FA	762	ATACHR	1	Contains last ATASCII character or plot point

Display Control Characters

02FE	766	DSPFLG	1	Display control character flag (1 = display control characters)

KEYBOARD

Key Reading

02FC	764	CH	1	Contains value of last keyboard character in FIFO or $FF if FIFO is empty

Special Functions

0011	17	BRKKEY	1	**BREAK** key flag (normally nonzero; set to 0 by **BREAK**)
02B6	694	INVFLG	1	Inverse video flag (norm = 0; set by ATARI key)
02BE	702	SHFLOK	1	Shift/control lock control flag ($00 = no lock (norm); $40 = caps lock; $80 = control lock) Set to $40 on power up and **SYSTEM RESET**; reset by **CAPS LOWR**, **CAPS LOWR SHIFT**, or **CAPS LOWR CTRL**.
02FF	767	SSFLAG	1	Start/stop flag (norm = 0; set by **CTRL 1**).

CENTRAL I/O (CIO) ROUTINE

I/O Control Block

0340-034F (832-847) IOCB			16	I/O control block 0
0350-035F (848-863) IOCB			16	I/O control block 1
0360-036F (864-879) IOCB			16	I/O control block 2
0370-037F (880-895) IOCB			16	I/O control block 3
0380-038F (896-911) IOCB			16	I/O control block 4
0390-039F (912-927) IOCB			16	I/O control block 5
03A0-03AF (928-943) IOCB			16	I/O control block 6
03B0-03BF (944-959) IOCB			16	I/O control block 7
0340	832	ICHID	1	Handler I.D. (see Section 5; initialized to $FF at power up and SYSTEM RESET)
0341	833	ICDNO	1	Device number
0342	834	ICCMD	1	Command byte
0343	835	ICSTA	1	Status
0344	836	ICBAL/ICBAH	2	Buffer address
0346	838	ICPTL/ICPTH	2	PUT BYTE vector (points to CIO's "IOCB not OPEN" at power up and SYSTEM RESET)
0348	840	ICBLL/ICBLH	2	Buffer length/byte count
034A	842	ICAX1/ICAX2	2	Auxiliary information
034C	844	ICAX3/ICAX6	4	Spare bytes for handler use

Zero Page IOCB

0020	32	ZIOCB	16	Zero page IOCB (Only the first 12 bytes (IOCBs) are moved by the CIO utility.)
0020	32	ICHIDZ	1	Handler index number (set to $FF on CLOSE)
0021	33	ICDNOZ	1	Device drive number
0022	34	ICCOMZ	1	Command byte
0023	35	ICSTAZ	1	Status byte
0024	36	ICBALZ,ICBALH	2	Buffer address
0026	38	ICPTLZ,ICPTHZ	2	PUT BYTE vector (points to CIO's "IOCB not OPEN" on CLOSE)
0028	40	ICBLLZ,ICBLHZ	2	Buffer length/byte count
002A	42	ICAX1Z,ICAX2Z	2	Auxiliary information
0002C	44	ICSPRZ (ICIDNO,ICOCHR)	4	CIO working variables CIDNO = ICSPRZ + 2; ICOCHR = ICSPRZ + 3

DEVICE STATUS

02EA	746	DVSTAT	4	Device status

DEVICE TABLE

031A	749	HATABS	38	Device handler table

SERIAL I/O (SIO) ROUTINE

Device Control Block

0300-030B	(768-779)	DCB	12	Device control block
0300	768	DDEVIC	1	Device bus I.D.
0301	769	DUNIT	1	Device unit number
0302	770	DCOMND	1	Device command
0303	771	DSTATS	1	Device status
0304	772	DBUFLO,DBUFHI	2	Handler buffer address
0306	774	DTIMLO	1	Device timeout
0308	776	DBYTLO,DBYTHI	2	Buffer length/byte count
030A	778	DAUX1,DAUX2	2	Auxiliary information

BUS SOUND CONTROL

0041	65	SOUNDR	1	Quiet/noisy I/O flag (0 = quiet)

ATARI CONTROLLERS

Joysticks

0278	632	STICK0-STICK3	4	Joystick position port
0284	644	STRIG0-STRIG3	4	Joystick trigger port

Paddles

0270	624	PADDL0-PADDL7	8	Paddle position port
027C	636	PTRIG0-PTRIG7	8	Paddle trigger port

Light Pen

0234	564	LPENH	1	Light pen horizontal position code
0235	565	LPENV	1	Light pen vertical position code
0278	632	STICK0-STICK3	4	Light pen button port

FLOATING POINT PACKAGE

00D4	212	FR0	6	Floating point register 0
00E0	224	FR1	6	Floating point register 1
00F2	242	CIX	1	Character index
00F3	243	INBUFF	1	Input text buffer pointer
00FB	251	DEGFLG/RADFLG	1	Degrees/radians flag (0 = DEGFLG; 6 = degrees; DEGFLG = 0)
00FC	252	FLPTR	2	Pointer to floating point number
0580	1408	LBUFF	96	Text buffer

POWER UP AND SYSTEM RESET

Diskette/Cassette Boot

0002	2	CASINI	2	Cassette boot initialization vector
000C	12	DOSINI	2	Diskette boot initialization vector

Environment Control

0008	8	WARMST	1	Warmstart flag (= 0 on power up; $FF on SYSTEM RESET)
000A	10	DOSVEC	2	Noncartridge control vector

INTERRUPTS

0010	16	POKMSK	1	POKEY interrupt mask
0042	66	CRITIC	1	Critical code section flag (nonzero = executing code is critical)

Real Time Clock

0012	18	RTCLOK	3	Real time frame counter (1/60 sec) (+0 = MSB; +1 = NSB; +2 = LSB)

System VBLANK Timers

0218	536	CDTMV1	2	System timer 1 value
021A	538	CDTMV2	2	System timer 2 value
021C	540	CDTMV3	2	System timer 3 value
021E	542	CDTMV4	2	System timer 4 value
0020	544	CDTMV5	2	System timer 5 value
0226	550	CDTMA1	2	System timer 1 jump address
0228	552	CDTMA2	2	System timer 2 jump address
022A	554	CDTMF3	2	System timer 3 flag
022C	556	CDTMF4	1	System timer 4 flag
022E	558	CDTMF5	2	System timer 5 flag

NMI Interrupt Vectors

0200	512	VDSLST	2	Display list interrupt vector (not used by the OS)
0222	546	VVBLKI	2	Immediate VBLANK vector
0224	548	VVBLKD	2	Deferred VBLANK vector

IRQ Interrupt Vectors

0202	514	VPRCED	2	Serial I/O bus proceed signal
0204	516	VINTER	2	Serial I/O bus interrupt signal
0206	518	VBREAK	2	BREAK instruction vector
0208	520	VKEYBD	2	Keyboard interrupt vector
020A	522	VUSERIN	2	Serial I/O bus receive data ready
020C	524	VSEROR	2	Serial I/O bus transmit ready
020E	526	VSEROC	2	Serial I/O bus transmit complete

0210	528	VTIMR1	2	POKEY timer vector (not used by OS)
0212	530	VTIMR2	2	POKEY timer vector (not used by OS)
0214	532	VTIMR4	2	POKEY timer vector (not used by OS)
0216	534	VIMIRQ	2	General IRQ vector

Hardware Register Updates

0230	560	SDLSTL	1	Screen display list address
0231	561	SDLSTH	1	Screen display list address
02C0	704	PCOLRx	4	Color register
02C4	708	PCOLORx	5	Color register
02F3	755	CHACT	1	Character control
02F4	756	CHBAS	1	Character address base register ($E0 = uppercase, number set; $E2 = lowercase, special graphics set; default = $E0)

USER AREAS

Note: The following areas are available to you in a nonnested environment:

0080	128	128
0480	1152	640

TABLE E-2 HARDWARE ADDRESSES

Address Hex	Dec	Register Name	Function	OS Hex	Shadow Dec	Name
ANTIC CHIP						
D400	54272	DMACTL	Direct memory access (DMA) control (WRITE)	22F	559	SDMCTL
D401	54273	CHACTL	Character control (WRITE)	2F3	755	CHART
D402	54274	DLISTL	Display list pointer low byte (WRITE)	230	560	SDLSTL
D403	54275	DLISTH	Display list pointer high byte (WRITE)	231	561	SDLSTH
D404	54276	HSCROL	Horizontal scroll (WRITE)			
D405	54277	VSCROL	Vertical scroll (WRITE)			
D407	54279	PMBASE	Player-missile base address (WRITE)			
D409	54281	CHBASE	Character base address (WRITE)	2F4	756	CHBAS
D40A	54282	WSYNC	Wait for horizontal sync (WRITE)			
D40B	54283	VCOUNT	Vertical line counter (READ)			
D40E	54286	NMIEN	Nonmaskable interrupt (NMI) enable (WRITE)			
D40F	54287	NMIRES	Reset NMIST (WRITE)			
D40F	54287	NMIST	NMI status (READ)			

D410-D4FF (54288-54527) Repeat ANTIC addresses D400 through D40F.

CTIA/GTIA CHIP

PLAYER-MISSILE GRAPHICS CONTROL

Horizontal Position Control (WRITE)

D000	53248	HPOSP0	Horizontal position player 0
D001	53249	HPOSP1	Horizontal position player 1
D002	53250	HPOSP2	Horizontal position player 2
D003	53251	HPOSP3	Horizontal position player 3
D004	53252	HPOSM0	Horizontal position missile 0
D005	53253	HPOSM1	Horizontal position missile 1
D006	53254	HPOSM2	Horizontal position missile 2
D007	53255	HPOSM3	Horizontal position missile 3

Collision Control (READ)

D000	53248	M0PF	Missile 0 to playfield
D001	53249	M1PF	Missile 1 to playfield
D002	53250	M2PF	Missile 2 to playfield
D003	53251	M3PF	Missile 3 to playfield
D004	53252	P0PF	Player 0 to playfield
D005	53253	P1PF	Player 1 to playfield
D006	53254	P2PF	Player 2 to playfield
D007	53255	P3PF	Player 3 to playfield
D008	53256	M0PL	Missile 0 to player
D009	53257	M1PL	Missile 1 to player
D00A	53258	M2PL	Missile 2 to player
D00B	53259	M3PL	Missile 3 to player
D00C	53260	P0PL	Player 0 to player
D00D	53261	P1PL	Player 1 to player
D00E	53262	P2PL	Player 2 to player
D00F	53263	P3PL	Player 3 to player

Collision Clear (WRITE)

D01E	53278	HITCLR	Collision clear

Size Control (WRITE)

Note: 0 = normal, 1 = double, 3 = quadruple size.

D008	53256	SIZEP0	Size of player 0
D009	53257	SIZEP1	Size of player 1
D00A	53258	SIZEP2	Size of player 2
D00B	53259	SIZEP3	Size of player 3
D00C	53260	SIZEM	Sizes of all missiles

Graphics Registers (WRITE)

D00D	53261	GRAFP0	Graphics for player 0
D00E	53262	GRAFP1	Graphics for player 1
D00F	53263	GRAFP2	Graphics for player 2
D010	53264	GRAFP3	Graphics for player 3
D011	53265	GRAFM	Graphics for all missiles

Joystick Controller Triggers (READ)

D010	53264	TRIG0	Read joystick 0 trigger	284	644	STRIG0
D011	53265	TRIG1	Read joystick 1 trigger	285	645	STRIG1
D012	53266	TRIG2	Read joystick 2 trigger	286	646	STRIG2
D013	53267	TRIG3	Read joystick 3 trigger	287	647	STRIG3

Color-Luminance Control (WRITE)

D012	53266	COLPM0	Color-luminance player-missile 0	2C0	704	COLR0
D013	53267	COLPM1	Color-luminance player-missile 1	2C1	705	PCOLR1
D014	53268	COLPM2	Color-luminance player-missile 2	2C2	706	PCOLR2
D015	53269	COLPM3	Color-luminance player-missile 3	2C3	707	PCOLR3
D016	53270	COLPF0	Color-luminance playfield 0	2C4	708	COLOR0
D017	53271	COLPF1	Color-luminance playfield 1	2C5	709	COLOR1
D018	53272	COLPF2	Color-luminance playfield 2	2C6	710	COLOR2
D019	53273	COLPF3	Color-luminance playfield 3	2C7	711	COLOR3
D01A	53274	COLBK	Color-luminance background	2C8	712	COLOR4

Priority Control (WRITE)

D01B	53275	PRIOR	Priority selection	26F	623	GPRIOR

Graphics Control (WRITE)

D01D	53277	GRACTL	Graphics control

MISCELLANEOUS I/O FUNCTIONS

PAL/NTSC Systems

D014	53268	PAL	Read PAL/NTSC bits

Console Switches (set to 8 during VBLANK)

D01F	53279	CONSOL	Write console switch port
D01F	53279	CONSOL	Read console switch port

POKEY CHIP

Audio (WRITE)

D200	53760	AUDF1	Audio channel 1 frequency
D201	53761	AUDC1	Audio channel 1 control
D202	53762	AUDF2	Audio channel 2 frequency
D203	53763	AUDC2	Audio channel 2 control
D204	53764	AUDF3	Audio channel 3 frequency
D205	53765	AUDC3	Audio channel 3 control
D206	53765	AUDF4	Audio channel 4 frequency
D207	53767	AUDC4	Audio channel 4 control
D208	53768	AUDCTL	Audio control

Start Timer (WRITE)

D209	53769	STIMER	Resets audio-frequency dividers to AUDF values			

Pot Scan (Paddle Controllers)

D200	53760	POT 0	Read pot 0	270	624	PADDL0
D201	53761	POT 1	Read pot 1	271	625	PADDL1
D202	53762	POT 2	Read pot 2	272	626	PADDL2
D203	53763	POT 3	Read pot 3	273	627	PADDL3
D204	53764	POT 4	Read pot 4	274	628	PADDL4
D205	53765	POT 5	Read pot 5	275	629	PADDL5
D206	53766	POT 6	Read pot 6	276	630	PADDL6
D207	53767	POT 7	Read pot 7	277	631	PADDL7
D208	53768	ALLPOT	Read 8-line pot-port state			
D20B	53771	POTGO	Start pot scan sequence (written during VBLANK)			

Keyboard Scan and Control (READ)

D209	53769	KBCODE	Keyboard code	2FC	764	CH

Random Number Generator (READ)

D20A	53770	RANDOM	Random number generator			

Serial Port

D20A	53770	SKRES	SKSTAT reset (WRITE)			
D20D	53773	SERIN	Serial port input (READ)			
D20D	53773	SEROUT	Serial port output (WRITE)			
D20F	53775	SKCTLS	Serial port 4-keyboard control (WRITE)	232	562	SSKCTL
D20F	53775	SKSTAT	Serial port 4-keyboard status register (READ)			

IRQ Interrupt

D20E	532774	IRQEN	IRQ interrupt enable (WRITE)	10	16	POKMSK
D20E	532775	IRQST	IRQ interrupt status (READ)			

D210-D2FF (53776-54015) Repeat D200-D20F (53760-53775)

PIA CHIP

Joystick Read/Write Registers

D300	54016	PORTA	Writes or reads data from Controller jacks 1 and 2 if bit 2 of PACTL = 1. Writes to direction-control register if bit 2 of PACTL = 0.	278 279	632 633	STICK0 STICK1
D301	54017	PORTB	Writes or reads data from Controller jacks 3 and 4 if bit 2 of PBCTL = 1. Writes to direction-control register if bit 2 of PBCTL = 0.	27A 27B	634 635	STICK2 STICK3
D302	54018	PACTL	Port A control (set to $3C by IRQ code).			
D303	54019	PBCTL	Port B control (set to $3C by IRQ code).			

D304-D3FF (54020-54271) Repeat D300-D303 (54016-54019)

APPENDIX F

PROGRAM CONVERSIONS

COPYRIGHT WARNING
Computer programs are protected by the Copyright Laws. The owner of a particular copy of a copyrighted program generally may adapt that program to run on his particular machine. However, there are limits on this right, and in particular, such adaptations *may not be transferred* to a third party without authorization from the copyright owner.

CONVERTING PROGRAMS TO ATARI MICROSOFT BASIC II

The COMMODORE PET* BASIC, APPLE** APPLESOFT** BASIC, and RADIO SHACK*** LEVEL II BASIC were all written by Microsoft. The overall approach and syntax of these BASIC languages has been kept compatible whenever possible to allow both programs and programmers to move easily from machine to machine. This appendix reviews the difference and indicates how to work around them when converting to ATARI Microsoft BASIC II.

Microsoft divided its original BASIC into several different levels: 4K, 8K, extended, and full. Each successive level was a superset of the previous level and required more memory. When a manufacturer requested BASIC, the specific level to start from was determined by the memory constraints of the target machine. One source of incompatibility is due to starting at different levels. PET BASIC and APPLE APPLESOFT BASIC are based on the 8K level. RADIO SHACK LEVEL II and ATARI Microsoft BASIC II are based on the full language level. Fortunately, this makes conversion into ATARI Microsoft BASIC II easy. The key language differences between 8K and full BASIC are the following:

- DATA TYPES: In 8K BASIC, double precision is not supported. Only 9 digits of accuracy are available. Integers can be used but they are converted to single precision before any arithmetic is done, so their only advantage is small storage requirements—not speed.
- PRINT USING is not available, so you have to format your own numbers in 8K BASIC.
- The advanced statements: IF...THEN...ELSE, DEFINT, DEFSNG, DEFDBL, DEFSTR, TRON, TROFF, RESUME, and LINE INPUT are not supported in 8K BASIC.
- The functions, INSTR and STRING$, are not supported in 8K BASIC.
- Arrays can only be single dimensioned in 8K BASIC.
- User-defined functions can only have one argument in 8K BASIC.

By far the most difficult areas for conversion are machine-dependent features such as graphics and machine language use. In all programming it is important to isolate the uses of the features and document the assumption made about the machine.

*PET is a registered trademark of Commodore Business Machines, Inc.
**APPLE and APPLESOFT are registered trademarks of APPLE COMPUTER.
***RADIO SHACK is a registered trademark of TANDY CORPORATION.

CONVERSIONS FROM COMMODORE (PET) BASIC VERSION 4.0

APPENDIX G

Most of the difficulty in converting from Commodore (PET) BASIC (used on Commodore PET computers) comes from specific hardware features rather than the BASIC language since it is a strict implementation of the 8K level. Some of the conversion considerations are:

- The Commodore PET character set has been extended to 256 characters. These characters are block graphics characters. In order to emulate this feature of the Commodore PET, you should set up a RAM-based character set on your ATARI Home Computer.
- Commodore PET BASIC has built-in constants as follows: TI$ (TIME$ for ATARI Computers) and TI (TIME for ATARI Computers), ST for the STATUS of the last I/O operation and a pi symbol for the constant pi.
- Commodore PET I/O is done with special statements that control its IEEE bus. The arguments to OPEN are completely different from other machines and must be completely changed. The exact format of sending the characters is done by specifying a channel number with PRINT and INPUT statements, which is the same as ATARI Microsoft BASIC II, so only the OPEN and control statements need to be reprogrammed.
- The display size of the Commodore PET is 40 by 25. If menus are designed for this layout, they need to be reprogrammed.
- PEEKs and POKEs are always very machine dependent. Commodore PET programs often use PEEK and POKE to control cursor positioning because there is no direct way to change the cursor position. Each PEEK and POKE must be examined and reprogrammed.
- Commodore PET programs often embed cursor control characters in literal text strings. The ATARI Microsoft BASIC II also supports this feature but the character codes are different and must be changed.
- The Commodore PET calls CLEAR, CLR.
- Any use of machine language through the Commodore PET EXEC statement has to be carefully examined because, although the microprocessor is the same, the layout of memory and the way of passing arguments to BASIC and receiving them from BASIC are quite different.
- Since the Commodore PET does not support sound or true graphics there is no conversion problem in these areas.
- RND is different. RND with a positive argument (generally 1) returns a number between 0 and 1.

Overall, if a special character set is set up identical to the Commodore PET's, it should be quite easy to convert programs that do not make heavy use of machine language or PEEK and POKE.

CONVERSION TO ATARI MICROSOFT BASIC II

Use the following table to convert a software program developed under Commodore (PET) BASIC 4.0.

Note: For simplicity, those universal BASIC commands such as RUN, CONT, and POKE have been omitted. In those cases, no conversion is necessary.

The following table can also be used to perform diskette-based functions. Commodore (PET) BASIC 4.0 is a diskette-based language that must be supported by the ATARI Computer DOS options.

COMMODORE (PET) COMMAND	**Equivalent ATARI Computer DOS OPTION**	**ATARI Microsoft BASIC**
DIRECTORY	**A** RETURN DIRECTORY—SEARCH SPEC, LIST FILE? RETURN	
COPY	**C** RETURN COPY—FROM,TO? **D1:***filename*,**D2:***filename* RETURN	
RENAME	**E** RETURN RENAME,GIVE OLD NAME,NEW **D2:***old filename, new filename* RETURN	NAME
SCRATCH	**D** RETURN DELETE FILESPEC **D2:***filename* RETURN TYPE "Y" TO DELETE *filename* **Y** RETURN	KILL
HEADER	**I** RETURN WHICH DRIVE TO FORMAT?	

Check the logical flow of the software that you wish to convert to determine the direction of these commands. You have to program around their use, depending upon the results you wish to accomplish with your software application.

CONVERTING TRS-80 RADIO SHACK PROGRAMS TO ATARI MICROSOFT BASIC II

APPENDIX H

Radio Shack BASIC is based on full Microsoft BASIC, so converted programs will make much better use of the features of ATARI Microsoft BASIC II than APPLE or Commodore PET programs. ATARI Microsoft BASIC II does have some additional features, such as COMMON, because it was written later and because the memory limitation for storing BASIC itself is not as restrictive on the ATARI Computer as it is on the Radio Shack computer. The term Radio Shack BASIC refers to the BASIC built into the Model I and Model III computers, and called "Level II" BASIC. The BASIC on the Model II is very similar, but it is not specifically covered here.

- The Radio Shack display size poses the greatest problem in converting TRS-80 BASIC programs because it is 16 by 64. Programs that use the full 64 characters for tables or menus need to be changed.
- Radio Shack supports a form of graphics that allow black and white displays of 128 by 48 pixels intermixed with characters. The only statements for manipulation of the graphics are: CLS (clear screen), SET (turn a point on), RESET (turn a point off), and POINT (test the value of a point on the screen).
- Radio Shack does not store the up-arrow character in the standard ASCII position, so it has to be translated when moving programs onto the ATARI Computer.
- Radio Shack PRINTER I/O is done with LPRINT and LLIST without opening a device. Radio Shack cassette I/O is done with PRINT or INPUT to channels 1 and 2 (two drives can be supported). The format of files on cassette is completely different.
- Calls to machine language are done with USR. Because Radio Shack computers use the Z-80 processor instead of the 6502, machine language routines have to be completely rewritten.
- PEEKs and POKEs cannot be directly converted. PEEK and POKE are not heavily used on the Radio Shack computers.
- The cursor-positioning syntax is an @ after PRINT in Radio Shack BASIC and "AT" in ATARI Microsoft BASIC II.
- The error codes returned by ERR are completely different.

TRS-80	ATARI	DEFINITION
CDBL(exp)	————	Returns double-precision representation of expression.
CINT(exp)	————	Returns largest integer not greater than the expression.
CLOAD	CLOAD LOAD "C:"	Loads a BASIC program from tape.
CLOAD?	VERIFY "C:filespec"	Verifies BASIC program on tape to one in memory.
CSNG(X)	Automatically truncates	Returns single-precision representation of the expression.
EDIT ln	AUTO line number	Lets you edit specified line number. Use cursor control keys.
FIX(x)	SGN(X)*INT(ABS(X))	Truncates all digits to the right of the decimal point.
INPUT#-1	OPEN#5, "C:" INPUT INPUT#5	INPUT reads data from cassette tape.
LLIST	LIST "P:" mm-nn	Lists program to printer.
LPRINT	OPEN#4, "P:" OUTPUT PRINT#4, "TEST"	Prints a line on printer.
PRINT MEM	PRINT FRE (0)	Prints free memory size.
POINT (X,Y)	OPEN#5, "D:" INPUT or GET#iocb, AT(s,b) INPUT#5, AT(sector,byte) or PUT#iocb, AT(s,b)	
PRINT @ n, list	PRINT#6, AT(X,Y);list	
PRINT#-1	CSAVE	Writes data to cassette.
RANDOM	RANDOMIZE	Seeds the RND function.

CONVERTING APPLESOFT PROGRAMS TO ATARI MICROSOFT BASIC II

APPENDIX I

Applesoft started from exactly the same BASIC source as PET BASIC, so once again there are very few pure language issues in converting programs to ATARI Microsoft BASIC II.

- Apple added two language features to Applesoft to enhance compatibility with their integer BASIC. They are: ONERR for error trapping and POP for eliminating GOSUB entries. ONERR can be easily converted to ON ERROR in ATARI Microsoft BASIC II. POP has no equivalent since it allows a very unstructured form of programming where subroutines aren't really subroutines. To convert, add a flag, change the POP to set the flag, RETURN, and then have a statement at the RETURN point check the flag, clear it, and branch if it is set.
- The Apple default display size is different from the ATARI display (actual screen size is the same). Menus and tables laid out to use the full display have to be edited.
- The Apple disk and peripheral I/O scheme is unique. Prints to specific channels are used to activate plug-in peripheral cards. The prints for the cards all have to be reprogrammed.
- The most difficult conversion task is changing the graphics and sound statements. The overall Apple high-resolution display size is 280 by 192. The color control is fairly unusual because each pixel cannot independently take on all color values. The sound port is a single bit.

J APPENDIX CONVERTING ATARI 8K BASIC TO ATARI MICROSOFT BASIC II

ATARI Microsoft BASIC II has improved graphics capabilities. You should consider rewriting graphics sections to take advantage of player-missile graphics. The SETCOLOR registers have been changed so that registers 0, 1, 2, and 3 now refer to player-missiles. What was SETCOLOR 0,cc, and 11 is now SETCOLOR 4,cc, and 11. SETCOLOR numbers have changed so that what was 0, 1, 2, 3, and 4 for the register assignment is now 4, 5, 6, 7, and 8. Other graphics changes include a FILL instruction and a "chained" PLOT that replaces DRAWTO.

Microsoft has improved string-handling capabilities. If your initial program occupies too much RAM, you might consider compacting it by rewriting it in Microsoft.

There are minor differences in the RND() and other instructions when converting to ATARI Microsoft BASIC II. The RND() can be made to work identically to the 8K BASIC's if you include a RANDOMIZE statement as part of your program. Programs that you have listed in 8K BASIC onto diskette can be loaded with ATARI Microsoft BASIC II and, with a few changes, should run.

ATARI 8K BASIC	ATARI MICROSOFT BASIC	COMMENTS
ADR(VAR$)	VARPTR(VAR$) + 1	Identical.
CLR	CLEAR	
DEG	——-	No equivalent.
PLOT X,Y DRAWTO A,B	PLOT X,Y TO X,Y	Draws a line on the TV screen in graphics modes. Use hyphen for number range.
LIST mm,nn	LIST mm-nn	
LOCATE X,Y,VAR	VAR = ASC(SCRN$(X,Y))	Locates value on register.
LPRINT "Hello"	OPEN#7, "P:" OUTPUT PRINT#7, "Hello"	Prints "Hello" on the printer.
OPEN #iocb, aexp1,aexp2, filespec	OPEN #iocb, filespec INPUT	
POINT #iocb, sector, byte	INPUT #iocb, AT (sector, byte) or PRINT #iocb at (S,E)	

ATARI 8K BASIC	ATARI MICROSOFT BASIC	COMMENTS
POP	———-	Use the USR function to call a machine language routine. POP stack in 6502 code.
POSITION X,Y PRINT #6,	PRINT#6, AT(X,Y)	
SOUND voice, pitch,noise,volume	SOUND voice, pitch,noise,volume, duration	The duration is a new option. Duration is given in 1/60 of a second called jiffies. Thus, SOUND works the same when converting programs to Microsoft BASIC II.
TRAP exp	ON ERROR exp	Identical.
USR(addr,list)	USR(addr,pointer)	You pass only one argument to the ATARI Microsoft BASIC II rather than an argument list.
XIO 18	FILL X1,Y1 TO X2,Y2	Microsoft's FILL plots points from X1,Y1 TO X2,Y2. It scans to the right as it fills the area from X1,Y1 TO X2,Y2. The sweep rightward stops and a new filling scan begins when a solid plotted line is met.

PADDLE, PTRIG, STICK, STRIG are done with PEEKs and POKEs in ATARI Microsoft BASIC II. See Section 6, "Game Controllers," for detailed description.

K APPENDIX

ATASCII CHARACTER SET

DECIMAL CODE	HEXADECIMAL CODE	CODE CHARACTER
0	0	
1	1	
2	2	
3	3	
4	4	
5	5	
6	6	
7	7	
8	8	
9	9	
10	A	
11	B	
12	C	
13	D	
14	E	
15	F	
16	10	
17	11	
18	12	
19	13	
20	14	
21	15	
22	16	
23	17	
24	18	
25	19	
26	1A	

DECIMAL CODE	HEXADECIMAL CODE	CODE CHARACTER
27	1B	
28	1C	
29	1D	
30	1E	
31	1F	
32	20	
33	21	
34	22	
35	23	
36	24	
37	25	
38	26	
39	27	
40	28	
41	29	
42	2A	
43	2B	
44	2C	
45	2D	
46	2E	
47	2F	
48	30	
49	31	
50	32	
51	33	
52	34	
53	35	
54	36	

DECIMAL CODE	HEXADECIMAL CODE	CODE CHARACTER
55	37	7
56	38	8
57	39	9
58	3A	:
59	3B	;
60	3C	<
61	3D	=
62	3E	>
63	3F	?
64	40	@
65	41	A
66	42	B
67	43	C
68	44	D
69	45	E
70	46	F
71	72	G
72	48	H
73	49	I
74	4A	J
75	4B	K
76	77	L
77	4D	M
78	4E	N
79	4F	O
80	50	P
81	51	Q
82	52	R
83	53	S

DECIMAL CODE	HEXADECIMAL CODE	CODE CHARACTER
84	54	T
85	55	U
86	56	V
87	57	W
88	58	X
89	59	Y
90	5A	Z
91	5B	[
92	5C	\
93	5D	]
94	5E	^
95	5F	_
96	60	♦
97	61	a
98	62	b
99	63	c
100	64	d
101	65	e
102	66	f
103	67	g
104	68	h
105	69	i
106	6A	j
107	6B	k
108	6C	l
109	6D	m
110	6E	n
111	6F	o
112	70	p

DECIMAL CODE	HEXADECIMAL CODE	CODE CHARACTER
113	71	
114	72	
115	73	
116	74	
117	75	
118	76	
119	77	
120	78	
121	79	
122	7A	
123	7B	
124	7C	
125	7D	
126	7E	
127	7F	
128	80	
129	81	
130	82	
131	83	
132	84	
133	85	
134	86	
135	87	
136	88	
137	89	
138	8A	
139	8B	
140	8C	
141	8D	

DECIMAL CODE	HEXADECIMAL CODE	CODE CHARACTER
142	8E	
143	8F	
144	90	
145	91	
146	92	
147	93	
148	94	
149	95	
150	96	
151	97	
152	98	
153	99	
154	9A	
155	9B	
156	9C	
157	9D	
158	9E	
159	9F	
160	A0	
161	A1	
162	A2	
163	A3	
164	A4	
165	A5	
166	A6	
167	A7	
168	A8	
169	A9	
170	AA	

DECIMAL CODE	HEXADECIMAL CODE	CODE CHARACTER
171	AB	+
172	AC	,
173	AD	—
174	AE	.
175	AF	/
176	B0	0
177	B1	1
178	B2	2
179	B3	3
180	B4	4
181	B5	5
182	B6	6
183	B7	7
184	B8	8
185	B9	9
186	BA	:
187	BB	;
188	BC	<
189	BD	=
190	BE	>
191	BF	?
192	C0	@
193	C1	A
194	C2	B
195	C3	C
196	C4	D
197	C5	E
198	C6	F
199	C7	G

DECIMAL CODE	HEXADECIMAL CODE	CODE CHARACTER
200	C8	H
201	C9	I
202	CA	J
203	CB	K
204	CC	L
205	CD	M
206	CE	N
207	CF	O
208	D0	P
209	D1	Q
210	D2	R
211	D3	S
212	D4	T
213	D5	U
214	D6	V
215	D7	W
216	D8	X
217	D9	Y
218	DA	Z
219	DB	[
220	DC	\
221	DD	]
222	DE	^
223	DE	—
224	E0	♦
225	E1	a
226	E2	b
227	E3	c
228	E4	d

DECIMAL CODE	HEXADECIMAL CODE	CODE CHARACTER
229	E5	
230	E6	
231	E7	
232	E8	
233	E9	
234	EA	
235	EB	
236	EC	
237	ED	
238	EE	
239	EF	
240	F0	
241	F1	
242	F2	
243	F3	
244	F4	
245	F5	
246	F6	
247	F7	
248	F8	
249	F9	
250	FA	
251	FB	
252	FC	
253	FD	
254	FE	
255	FF	

APPENDIX L

USING THE CIOUSR CALLING ROUTINES

There are three prewritten USR routines provided on the ATARI Microsoft BASIC II Extension Diskette. These routines provide a flexible way to interact with the central input/output (CIO) facilities of your ATARI Home Computer. These routines (or similar routines if you prefer to write your own) allow the BASIC program to send or retrieve data directly to or from an input/output control block (IOCB). The IOCB's are discussed in detail in the *ATARI Home Computer System Technical Reference Notes*. Refer to that document for a complete description of CIO capabilities.

These routines allow the BASIC programmer to perform such tasks as retrieving a disk directory, formatting a diskette, or conditioning a specific IOCB and its associated logical unit number to interface with RS-232 devices. Following is a brief description of how to use these routines in your own programs.

STEP 1. Inserting the Routines Into a BASIC Program

All three routines are contained in the file **CIOUSR** on the ATARI Microsoft BASIC II Extension Diskette. They are in a machine-readable format, ready to be poked directly into RAM. To allocate RAM for this purpose, use the OPTION RESERVE n statement where n should be at least 160. Get the starting address of the reserved area with the statement ADDR = VARPTR(RESERVE). Then, the following instructions can be used to put the routines into the BASIC program:

```
10 OPEN #1, "D:CIOUSR" INPUT
20 FOR T = 0 TO 159
30 GET #1,A
40 POKE ADDR + T,A:NEXT I
50 CLOSE #1
```

STEP 2. Setting Up the Data Array

The routines are now in the reserved area of the BASIC program. There are three routines called PUTIOCB, CALLCIO, and GETIOCB. PUTIOCB starts at RAM location ADDR. CALLCIO starts at ADDR + 61. GETIOCB starts at ADDR + 81.

The GETIOCB routine retrieves the user-alterable bytes from a specified IOCB and puts them into an integer array of length 10. You may alter any of these parameters and then put the new values back into the IOCB with the PUTIOCB routine. When the proper parameters have been set, the use of CALLCIO causes the IOCB values to be executed by the CIO facility. The next step is to dimension an integer array to use for retrieval and storage of the IOCB parameters. This array should be dimensioned to 10 using a BASE option of zero. Following is a list of the elements of the array and what each is used for:

Element Number	IOCB Parameter
0	This element is the number of the IOCB to be used (1 to 8).
1	COMMAND CODE
2	STATUS — returned
3	BUFFER ADDRESS
4	BUFFER LENGTH
5-10	AUX byte 1-6

Each element of an integer array has two bytes of data storage, so the buffer address in element 3 will fit into a single integer element.

STEP 3. Calling the USR Routines

A USR call is used to execute the CIOUSR routines. The GETIOCB routine returns to the program the current values of the specified IOCB's parameters. After changing these parameters in the array, you can effect some CIO function (such as, setting the baud rate on an RS-232 port), by calling the PUTIOCB routine to put the desired values into the specified IOCB. Then the CALLCIO routine is called to execute the CIO facility. Following is the syntax necessary to call each of the routines:

```
nvar = USR(addr,VARPTR(array(0)))
```

where:

nvar — a numeric variable that receives the status of the CIO function in the case of a CALLCIO call; otherwise it is not specifically affected by these routines.

addr — the starting address of the proper CIOUSR routine (in our current example these would be ADDR for PUTIOCB, ADDR + 61 for CALLCIO, and ADDR + 81 for GETIOCB).

array(0) — the array is the integer array the program uses for data retrieval and storage for the routines. Passing the VARPTR of element zero of this array to the routines tells them where to begin retrieving the data, starting with the IOCB number.

The following is an example program to set up and use an RS-232 port for telecommunications. Also see the "Disk Directory Program" in Appendix A for another example of the use of these routines. For the program to work properly, the RS-232 driver (file name RS232.SYS on your program diskette) has to be loaded during power up of your ATARI Home Computer system. To load the driver, copy the file RS232.SYS with an append option to the BASIC extension file AUTORUN.SYS.

```
COMPUTER:   SELECT ITEM OR RETURN FOR MENU
YOU TYPE:   C RETURN
COMPUTER:   COPY -- FROM, TO?
YOU TYPE:   RS232.SYS, AUTORUN.SYS/A RETURN
COMPUTER:   TYPE "Y" IF OK TO USE PROGRAM AREA
            CAUTION: A "Y"
            INVALIDATES MEM.SAV
YOU TYPE:   Y RETURN
```

```
100 !
110 !ROUTINE TO SET UP RS-232 PORT
120 !
130 :                                   !SET UP CIOUSR ROUTINE
                                        ADDRESSES
140 DIM CIO%(10),S%(10)
145 S%(0)=5:S%(1)=&0D
150 OPTION RESERVE 200
160 ADDR=VARPTR(RESERVE)                !SAVE BUFFER ADDRESS
170 PUTIOCB=ADDR                        !SAVE ADDRESS OF CIOUSR
                                        ROUTINES
180 CALLCIO=ADDR+61
190 GETIOCB=ADDR+81
200 OPEN #1,"D:CIOUSR" INPUT            !TRANSFER CIOUSR ROUTINES
                                        INTO RAM
210 FOR I=0 TO 159
220 GET #1,D:POKE ADDR+I,D
230 NEXT I
240 CLOSE #1
250 !                                   !SET UP CONFIGURATION
                                        PARAMETERS
260 OPEN #1, "K:" INPUT
270 CIO%(0)=2                           !IOCB NUMBER
280 CIO%(1)=3                           !COMMAND CODE FOR OPEN
290 Y=VARPTR(CIO%(3))                   !BUFFER ADDRESS
300 FSPEC$="R:"                         !PORT NUMBER
310 Z=VARPTR(FSPEC$)
315 Y=VARPTR(CIO%(3))
320 POKE Y,PEEK(Z+2)                    !STARTING LOCATION OF DEVICE
                                        BUFFER
330 POKE Y+1,PEEK(Z+1)
335 Y=VARPTR(S%(3))
340 CIO%(5)=13                          !AUX1 PARAMETER
350 !
360 A=USR(PUTIOCB,VARPTR(CIO%(0)))      !SET UP IOCB
370 A=USR(CALLCIO,VARPTR(CIO%(0)))      !EXECUTE CIO FACILITY
380 A=USR(GETIOCB,VARPTR(CIO%(0)))
390 !
```

```
400 CIO%(1) = 40                          !START CONCURRENT I/O
410 CIO%(5) = 13                          !SET AUX BYTES TO ZERO
470 A = USR(PUTIOCB,VARPTR(CIO%(0)))      !CHANGE IOCB
480 A = USR(CALLCIO,VARPTR(CIO%(0)))      !EXECUTE CIO FACILITY
490 A = USR(PUTIOCB,VARPTR(S%(0)))
500 !                                     !START COMMUNICATION
520 PRINT "STARTING LOOP"
530 GET #1,A
540 PUT #2,A
550 POKE 764,255                          !CLEAR KEYBOARD BUFFER
560 X = USR(CALLCIO,VARPTR(S%(0)))        !CHECK STATUS OF RS-232
570 IF PEEK(747) = 0 THEN 600             !NO CHARACTER SENT
580 GET #2,D                              !SEND CHARACTER
590 IF D < >10 THEN PRINT CHR$(D);
600 IF PEEK(764) < >255 THEN 530          !CHARACTER SENT FROM
                                          KEYBOARD
610 GOTO 560
```

To make subsequent CIO calls, you can repeat lines 400-490 with different IOCB parameters in the array CIO%.

M APPENDIX ACTIONS TAKEN WHEN PROGRAM ENDS

ACTIONS TAKEN			
Key Pressed or Statement Executed	**Close All Files**	**Run Out the Stack**	**Clear Sound**
STOP ERRORS **BREAK**	NO	NO	YES
Running off the last statement or "END"	YES	YES	YES
After a direct mode statement	NO	YES	NO
RUN	YES	NO	YES

Notes:

1. ATASCII stands for "ATARI ASCII." Letters and numbers have the same values as those in ASCII, but some of the special characters are different.
2. Add 32 to the uppercase code to get the lowercase code for that same letter.
3. To get ATASCII code, tell the computer (in direct mode) to PRINT ASC (" "). Fill the blank with the letter, character, or number of code. You must use the quotation marks!
4. The normal display is shown as keycaps with white symbols on a black background; the inverse display is shown as a keycap with black symbols on a white background.

ALPHABETICAL DIRECTORY OF RESERVED WORDS

APPENDIX N

RESERVED WORD	BRIEF SUMMARY OF BASIC II STATEMENT
ABS	Function returns absolute value (unsigned) of the variable or expression. **Example:** Y = ABS(A + B)
AFTER	Causes the placement of an entry on a time-interrupt list. The elapsed time to be associated with time interrupt is specified by the numeric expression in units of jiffies (1/60 of a second). **Example:** AFTER (180) GOTO 1000
AND	Logical operator: Expression is true only if both subexpressions joined by AND are true. **Example:** IF A = 10 AND B = 30 THEN END
ASC	String function returns the numeric ATASCII value of a single string character. **Example:** PRINT ASC(A$)
AT	Positions disk or screen output via PRINT statement. **Example:** PRINT AT(S,B)"START HERE"
ATN	Function returns the arctangent of a number or expression in radians. **Example:** PRINT ATN(A)
AUTO	Generates line numbers automatically. **Example:** AUTO 100,50
BASE	Used with OPTION statement, sets minimum value for array subscripts. **Example:** OPTION BASE 1
CHR	Used with OPTION statement, allocates RAM for alternate character sets, where: CHR1 = 1024 bytes are allocated (128 characters), CHR2 = 512 bytes are allocated (64 characters), CHR0 = frees the allocated RAM. **Example:** OPTION CHR1
CHR$	String function returns a single string character equivalent to a numeric value between 0 and 255 in ATASCII code. **Example:** PRINT CHR$(48)

RESERVED WORD	BRIEF SUMMARY OF BASIC II STATEMENT
CLEAR	Sets all strings to null and sets all variables to zeros. **Example:** CLEAR
CLEAR STACK	Resets all entries on the time stack to zero. **Example:** CLEAR STACK
CLOAD	Put programs on cassette tape into computer memory. **Example:** CLOAD
CLOSE	I/O statement closes a file at the conclusion of I/O operations. **Example:** CLOSE #6
CLS	Erases the text portion of the screen and sets the background color register to the indicated value, if present. **Example:** CLS 35
COLOR	Establishes the color register or character to be produced by subsequent PLOT and FILL statements. **Example:** COLOR 2
COMMON	A program statement that passes variables to a chained program. **Example:** COMMON A,B,C$
CONT	Continues program execution after a **BREAK** or STOP. **Example:** CONT
COS	Function returns the cosine of the variable or expression (degrees or radians). **Example:** A = COS(2.3)
CSAVE	Puts programs that are in computer memory onto cassette tape. **Example:** CSAVE
DATA	I/O statement lists data to be used in a READ statement. **Example:** DATA 2.3,"PLUS",4
DEF	Statement has two applications: (1) Defines an arithmetic or string function. **Example:** DEF SQUARE (X,Y) = SQR(X*X + Y*Y) (2) Defines default variable of type INT, SNG, DBL, or STR. **Example:** DEFINT I-N
DEL	Deletes program lines. **Example:** DEL 20-25

RESERVED WORD	BRIEF SUMMARY OF BASIC II STATEMENT
DIM	Reserves the specified amount of memory for matrix, array, or string array. **Example:** DIM A(3), B$(10,2,3)
END	Stops program, closes all files, and returns to BASIC command level. **Example:** END
EOF	Returns true (-1) if file is positioned at its end. **Example:** IF EOF(1) GOTO 300
ERL	Returns error line number. **Example:** PRINT ERL
ERR	Returns error code number. **Example:** IF ERR = 62 THEN END
ERROR	Generates error of code (see Appendix O). May call user ON ERROR routine or force BASIC to handle error. **Example:** ERROR 17
EXP	Function raises the constant e to the power of expression. **Example:** B = EXP(3)
FILL	Fills in area between two plotted points with a color. **Example:** FILL 10,10 TO 20,20
FOR...TO...STEP	Used with NEXT statement, repeats a sequence of program lines. The variable is incremented by the value of STEP. **Example:** FOR DAY = 1 TO 5 STEP 2
FRE(O)	Gives free space in memory available to programmer. **Example:** PRINT FRE(0)
GET	Reads a byte from an input device. **Example:** GET#1,D
GOSUB	Branches to a subroutine beginning at the specified line number. **Example:** GOSUB 210
GOTO	Branches to a specified line number. **Example:** GOTO 90
GRAPHICS	Establishes which of the display lists and graphics modes contained in the operating system are to be used to produce the screen display. **Example:** GRAPHICS 5

RESERVED WORD	BRIEF SUMMARY OF BASIC II STATEMENT
IF...THEN	If expression is true, the THEN clause is executed. Otherwise, the next statement is executed. **Example:** IF ENDVAL >0 THEN GOTO 200
IF...THEN...ELSE	If exp is true, the THEN clause is executed. Otherwise, the ELSE clause or next statement is executed. **Example:** IF X<Y THEN Y=X ELSE Y=A
INKEY$	Returns either a one-character string read from terminal or null string if no character pending at terminal. **Example:** A$=INKEY$
INPUT#	Reads data from a device. **Example:** INPUT #1,A,B
INPUT	Reads data from the keyboard. Semicolon after INPUT suppresses echo of carriage return/line feed. If a prompt is given, it appears as written; if not, a question mark appears in its place. **Example:** INPUT "VALUES";A,B
INSTR	Returns the numeric position of the first occurrence of Y$ in X$ scanning from the third character in X$. **Example:** INSTR(3,X$,Y$)
INT	Evaluates the expression for the largest integer less than expression. **Example:** C=INT(X+3)
KILL	Deletes a disk file. **Example:** KILL "D:INVEN.BAS"
LEFT$	Returns leftmost specified number of characters of the string expression. **Example:** B$=LEFT$(X$,8)
LEN	String function returns the length of the specified string in bytes or characters (1 byte contains 1 character). **Example:** PRINT LEN(B$)
LET	Assigns a value to a specific variable name. **Example:** LET X=I+5
LINE INPUT	Reads an entire line from the keyboard. Semicolon after LINE INPUT suppresses echo of carriage return/line feed. See INPUT. **Example:** LINE INPUT "NAME";N$
LIST	Displays or otherwise outputs the program list. **Example:** LIST 100-1000

RESERVED WORD	BRIEF SUMMARY OF BASIC II STATEMENT
LOAD	Loads a program file. **Example:** LOAD "D:INVEN"
LOCK	Sets the file locked condition for the file named in the string expression. **Example:** LOCK "D1:TEST.BAS"
LOG	Function returns the natural logarithm of a number. **Example:** D = LOG(Y-2)
MERGE	Merges program on disk with program in memory by line number. **Example:** MERGE "D:SUB1"
MID$	Returns characters from the middle of the string starting at the position specified to the end of the string or for the specified number of characters. **Example:** A$ = MID$(X$,5,10)
MOVE	Moves bytes of memory from one area to another so that the block is not changed. **Example:** MOVE 45000,50000,6
NAME	Changes the name of a disk file. **Example:** NAME "D:OLDFILE" TO "NEWFILE"
NEW	Deletes current program and variables. **Example:** NEW
NEXT	Causes a FOR/NEXT loop to terminate or continue depending on the particular variables or expressions. **Example:** NEXT I
NOT	Unary operator used in logical comparisons evaluates to 0 if expression is nonzero; evaluates to 1 if expression is 0. **Example:** IF A = NOT B
NOTE	Causes the current disk sector number to be stored into the first variable and the byte number into the second variable for the file associated with the IOCB#. **Example:** NOTE #1,S,B
ON ERROR	Enables error-trap subroutine beginning at specified line. If line = 0, disables error trapping. If line = 0 inside error-trap routine, forces BASIC to handle error. **Example:** ON ERROR GOTO 1000
ON...GOSUB	GOSUBs to statement specified by expression. (If exp = 1, to 20; if exp = 2, to 20; if exp = 3, to 40; otherwise, error.) **Example:** ON DATE% + 1 GOSUB 20,20,40

RESERVED WORD	BRIEF SUMMARY OF BASIC II STATEMENT
ON...GOTO	Branches to statement specified by expression (If INDEX = 1, to 20; if INDEX = 2, to 30; if INDEX = 2, to 40; otherwise, error.) **Example:** ON INDEX GOTO 20,30,40
OPEN	Opens a device. Mode must be one of: INPUT, OUTPUT, UPDATE, and APPEND. **Example:** OPEN #1, "D:INVEN.DAT" OUTPUT
OPTION BASE	Declares the minimum value for array subscripts; n is 0 or 1. **Example:** OPTION BASE 1
OPTION CHR	Allocates space for alternate character sets. **Example:** OPTION CHR1
OPTION PLM	Allocates space for player-missile graphics. **Example:** OPTION PLM1
OPTION RESERVE	Allocates free space for your use in assembly language program. **Example:** OPTION RESERVE(50)
OR	Logical operator used between two expressions. If either one is true, a "1" results. A "0" results only if both are false. **Example:** IF A = 10 OR B = 30 THEN END
PEEK	Function returns decimal form of contents of specified memory location. **Example:** PRINT PEEK (&2000)
PLM	Used with OPTION statement, allocates RAM for player-missile graphics, where: PLM1 = single-line resolution PLM2 = double-line resolution PLM0 = free the allocated RAM **Example:** OPTION PLM2
PLOT	Plots a single point on the screen or draws from one point to another. **Example:** PLOT 10,10 TO 20,20
POKE	Inserts the specified byte into the specified memory location. **Example:** POKE &2310,255
PRINT	I/O command causes output from the computer to the specified output device. **Example:** PRINT USING "!";A$,B$

RESERVED WORD	BRIEF SUMMARY OF BASIC II STATEMENT
PUT	Writes byte-oriented data to a data file. **Example:** PUT #3,4
RANDOMIZE	Reseeds the random number generator. **Example:** RANDOMIZE
READ	Reads the next items in the DATA list and assigns them to specified variables. **Example:** READ I,X,A$
REM	Remarks. Allows comments to be inserted in the program without being executed by the computer on that program line. Alternate forms are exclamation point (!) and apostrophe ('). **Example:** REM DAILY FINANCES
RENUM	Renumbers program lines. **Example:** RENUM 100,,100
RESERVE	Used with OPTION statement, reserves a specified number of bytes for your use. **Example:** OPTION RESERVE (512)
RESTORE	Resets DATA pointer to allow DATA to be read more than once. **Example:** RESTORE
RESUME	Returns from ON ERROR or time-interrupt routine to statement that caused error. RESUME NEXT returns to the statement after error-causing statement and RESUME line number returns to statement at line number. **Example:** RESUME
RETURN	Returns from subroutine to the statement immediately following the one in which GOSUB appeared. **Example:** RETURN
RIGHT$	Returns rightmost specified number of characters of the string expression. **Example:** C$ = RIGHT$(X$,8)
RND	Generates a random number. If parameter = 0, returns random between 0 and 1. If parameter > 0, returns random number between 0 and parameter. **Example:** E = RND(10)
RUN	Executes a program starting with the lowest line number. **Example:** RUN

RESERVED WORD	BRIEF SUMMARY OF BASIC II STATEMENT
SAVE	Saves the program in memory with name "filename." SAVE "filename" LOCK encrypts the program as it writes to disk. **Example:** SAVE"D:PROG"
SCRN$	The character or color number of the pixel at an X-coordinate and a Y-coordinate is returned as the value of the function, using the ASC function. **Example:** A$ = ASC(SCRN$ (23,5))
SETCOLOR	Associates a color and luminance with a color register. **Example:** SETCOLOR 0,5,5
SGN	1 if expression > 0 0 if expression = 0 -1 if expression < 0 **Example:** B = SGN(X + Y)
SIN	Function returns trigonometric sine of given value in degrees. **Example:** B = SIN(A)
SOUND	Statement initiates one of the sound generators. **Example:** SOUND 1,121,8,10,60
SPC	Used in PRINT statements, prints spaces. **Example:** PRINT SPC(5),A$
SQR	Function returns the square root of the specified value. **Example:** C = SQR(D)
STACK	Returns the number of entries available on time stack. **Example:** A = STACK
STATUS	Function accepts a single argument as either numeric or string then returns status of logical unit number or file. **Example:** ST = STATUS(2)
STOP	Causes execution to stop but does not close files. **Example:** STOP
STR$	Function returns a character string equal to numeric value given. **Example:** PRINT STR$(35)
STRING$	Returns a string composed of a specified number of replications of A$. **Example:** X$ = STRING$(100,"A") Returns a string 100 units long containing CHR$(65). **Example:** Y$ = STRING$(100,65)

RESERVED WORD	BRIEF SUMMARY OF BASIC II STATEMENT
TAB	Used in PRINT statements, tabs carriage to specified position. **Example:** PRINT TAB(20),A$
TAN	Returns tangent of the expression (in radians). **Example:** D = TAN(3.14)
TIME	Returns numeric representation of time from the real time clock. **Example:** ATM = TIME
TIME$	Returns the time of day in a 24-hour notation in the string. The format is HH:MM:SS. **Example:** TIME$ = "08:55:05" PRINT TIME$
TROFF	Turns trace off. **Example:** TROFF
TRON	Turns trace on. **Example:** TRON
UNLOCK	Statement terminates the LOCK condition. **Example:** UNLOCK "D1:DATA.OUT"
USING	Provides string format for printed output. **Examples:** PRINT USING "**###.##**";PDOLLARS
USR	Function returns results of a machine-language subroutine. **Example:** X = USR(SVBV, VARPTR(ARR(0)))
VAL	Function returns the equivalent numeric value of a string. **Example:** PRINT VAL("3.1")
VARPTR	Returns address of variable or graphics area in memory, or zero if variable has not been assigned a value. **Example:** I = VARPTR(X)
VERIFY	Compares the program in memory with the one on filename. If the two programs are not found to be identical, it returns an error. **Example:** VERIFY "D1:DATA.OUT"
WAIT	Equality comparison, pauses execution until result equals third parameter. **Example:** WAIT &E456,&FF,30
XOR	Performs bitwise exclusive OR (integer). **Example:** IF A XOR B = 0 THEN END

O APPENDIX

ERROR CODES

CODE	SCREEN COMMENTS	ERROR
1	NEXT WITHOUT FOR ERROR IN Line #.	NEXT was used without a matching FOR statement. This error may also happen if NEXT variable statements are reversed in a nested loop.
2	SYNTAX ERROR IN Line #.	Incorrect punctuation, open parenthesis, illegal characters, and misspelled keywords causes syntax errors.
3	RETURN WITHOUT GOSUB ERROR.	A RETURN statement was placed before the matching GOSUB.
4	OUT OF DATA ERROR IN Line #.	A READ or INPUT # statement was not given enough data. DATA statement may have been left out or all data read from a device (diskette, cassette).
5	FUNCTION CALL ERROR IN Line #.	Program attempted to execute an operation using an illegal parameter. Examples: square root of a negative number, or negative LOG.
6	OVERFLOW.	A number that is too large or small has resulted from a mathematical operation or keyboard input.
7	OUT OF MEMORY ERROR.	All available memory has been used or re served. This may occur with very large matrix dimensions, nested branches such as GOTO, GOSUB, and FOR/NEXT loops.
8	UNDEF'D LINE ERROR IN Line #.	An attempt was made to refer or branch to a nonexistent (''undefined'') line.
9	SUBSCRIPT ERROR IN Line #.	A matrix element was assigned beyond the dimensioned range.
10	REDEF'N ERROR IN Line #.	Attempt to dimension a matrix that had already been dimensioned using the DIM statement or defaults.
11	DIVISION BY ZERO.	Using zero in the denominator is illegal.
12	ILLEGAL DIRECT ERROR.	The use of INPUT, GET, or DEF in the direct mode is illegal.

CODE	SCREEN COMMENTS	ERROR
13	TYPE MISMATCH ERROR IN Line #.	It is illegal to assign a string variable to a numeric variable and vice versa.
14	FILE I/O ERROR	General I/O error.
15	QUANTITY TOO BIG ERROR IN Line #.	String variable exceeds 255 characters in length.
16	FORMULA TOO COMPLEX ERROR.	A mathematical or string operation was too complex. Break into shorter steps.
17	CAN'T CONTINUE ERROR.	A CONT command in the direct mode cannot be done because program encountered an END statement.
18	UNDEF'D FUNCTION ERROR.	The USR function cannot be carried out. User code has an error in logic or USR start points to wrong memory address.
19	NO RESUME ERROR IN Line #.	End of program was reached in error-trapping mode.
20	RESUME WITHOUT ERROR IN Line #.	RESUME was encountered before ON ERROR GOTO statement.
21	FOR WITHOUT NEXT ERROR.	NEXT statement was encountered before a FOR statement.
22	LOCK ERROR	Attempt to modify or list a program saved with the LOCK option.
23	TIME ERROR	Time interrupts conflict with each other. AFTER statements not followed by RESUME.

For an explanation of the following error codes, see *ATARI Disk Operating System II Reference Manual.*

128	BREAK abort
129	IOCB
130	Nonexistent device
131	IOCB write only
132	Invalid command
133	Device or file not open
134	Bad IOCB number
135	IOCB read-only error
136	EOF
137	Truncated record
138	Device timeout
139	Device NAK
140	Serial bus
141	Cursor out of range

142	Serial bus data frame overrun error
143	Serial bus data frame checksum error
144	Device-done error
145	Read after write-compare error
146	Function not implemented
147	Insufficient RAM
160	Drive number error
161	Too many OPEN files
162	Disk full
163	Unrecoverable system data I/O error
164	File number mismatch
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166	POINT data length error
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171	POINT invalid

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